Brazil
An Analysis of Environmental Problems in the Amazon

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PREFACE

This report was initiated by a mission to Brazil in December 1989, led by Robert Schneider (LA1CO) who is the principal author of the report. Many people have given generously of their time to read and help improve previous drafts of this report. The authors wish to thank particularly Nancy Birdsall, Hans Binswanger and Michael Michaely. Any errors remain the responsibility of the authors. Mission members included John McKenna (LATAG), Chantal Dejou (YP), John Butler, and Richard Barrows (consultants). Annex I was written by Donald Sawyer (consultant). Annexes II-VII are largely the work of John Butler. Richard Barrows authored Annex VIII. Elizabete Delima provided valuable assistance in the processing of the report. The volume also includes the observations and comments of the Brazilian Government agencies.

BRAZIL: AN ANALYSIS OF ENVIRONMENTAL PROBLEMS IN THE AMAZON

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Executive Summary

1. Amazon deforestation has captured the world's attention as have few other issues. Based largely on the exceptionally high rate of deforestation in 1987, journalists and scientists described an alarming picture of the overall rate of deforestation and its consequences, including possible increases in global warming and the threat of loss of habitat for the world's richest stock of genetic material. For Brazil the implications include loss of potentially productive land and river resources through erosion and sedimentation, and possible microclimatic changes resulting from alterations in the hydrological cycle.

2. To develop appropriate polices to do something about mismanagement of Amazonian resources requires more than a sense of urgency. It requires gaining a perspective on the actual magnitude of the problem, understanding the forces that influence individuals' behavior in the forest, and investigating the actual and potential role of government.

3. This study has been undertaken to improve the analytical and factual framework that underpins the Bank's approach to problems of economic development and environmental degradation in the Amazon. The study has investigated the incentives and the major economic and environmental issues surrounding the most important economic and environmental actors in the Amazon: cattle ranchers, crop farmers, loggers, placer miners, forest "extractivists," large-scale miners, and hydropower developers. Although the study incorporates a large amount of detail, it makes no attempt to provide a comprehensive description of environmental and economic issues in the Amazon.

4. The following seven propositions are the major generalizations to emerge from this study.[1] This executive summary will briefly review the major points supporting each of these generalizations. This will be followed by a review of the major policy recommendations.

Propositions

- Rate of Deforestation: deforestation in the Amazon is occurring more slowly than is generally believed, and will probably continue at a slower pace for economic and demographic reasons;

- "Nutrient Mining": even though the pressure for deforestation has declined, it will continue, based on the economics of nutrient

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/1 Clearly these generalizations are not true in every time and place. To reduce the level of generalization required, the Brazilian Government would favor a study at the level of messoregions or microregions. Such a study is not a substitute for the current one however, which is intended principally to give further work coherence and direction.

mining--the extraction through logging, annual cropping, and ranching of the nutrients of the forest canopy and soil;

- Importance of Road Building: market forces will tend to promote nutrient mining (and prevent the emergence of sustainable agricultural techniques) as long as new roads keep land abundant and cheap;

- Local Support: policies to restrict deforestation will be extremely difficult to implement due to lack of local support;

- Opportunity Costs: while the economic opportunity cost to Brazil as a whole of reducing or eliminating further agricultural exploitation in the Amazon is very low, the cost of enforcing controls on deforestation would be high; and

- Reasons to Control Deforestation: the major reasons to reduce deforestation are (1) to maximize the net benefits to society of the information embodied in the yet unknown numbers of threatened plant and animal species, (2) to reduce greenhouse gas emissions from forest burning, (3) to prevent problems of river siltation and sedimentation, and (4) to prevent possible climate change at the local level.

- Potential for North-South Trade in Greenhouse Gas Reduction: Comparing the purchase and rental price of land in the Amazon to the carbon content of a hectare of dense tropical forests suggests that the North could contract with landowners in the Amazon not to burn. A price cheaper than current proposals for a carbon tax (say US$3.50 a ton of carbon or a penny a gallon of gas) would still make them better off than they are currently. In other words, on a global scale, prevention of deforestation in the Amazon may be one of the lowest-cost ways to reduce greenhouse emissions. Thus both donors and Brazil would benefit from transfers to reduce deforestation.

Discussion

5. Rate of Deforestation. The public appears to have an exaggerated view of the rate of deforestation in the Brazilian Amazon. The most reliable estimates to date (those of INPE) show that approximately 8% of the Amazon has been deforested.[/2] Deforestation appears to be occurring at a rate of 20,000-30,000 square kilometers per year. This represents 1-1.5% of the forested area of the Amazon per year. The perception of much more rapid loss is partly explained by the use of estimates based on exponential projections. There is no scientific justification for such extrapolations.

/2 Approximately 2% of the Amazon, mostly in Mato Grosso and Pará, has regrown into secondary forest and could not be detected as disturbed forest except under the most recent (1988) color satellite imagery. Thus for purposes of comparison with previously reported deforestation numbers, an area of 5.1% of the legal Amazon, and 3.9% of the Northern Region, are the appropriate numbers.

6. The rate of deforestation has slowed in recent years and will probably continue at a lower rate, but will not stop without intervention. Three forces account for the slackening of pressures:

(a) A slowdown in road building has reduced the availability of new land in the north. This emerging land scarcity has led to higher land prices, which tend to dampen the incentive to sell land in the south in order to migrate to the Amazon. In 1960, prior to the soybean boom in the south, a hectare of land in the south was worth approximately two hectares of land in the north. In 1982, with intense expansion of farm size in the south and readily accessible land in the north, a migrant from the south could buy 15 hectares of land in the north for every hectare sold in the south. By 1987, this ratio had fallen to 7, due largely to increased land values in the north.

(b) Second, the stock of potential migrants has ceased to grow: the number of rural males in Brazil between 20 and 39 years of age remained essentially constant during the 1980s, following an increase of 36% over the previous 30 years.

(c) Third, expectations about the quality of life at the frontier have fallen, greatly reducing the incentives for migrating towards the Amazon.

7. The evidence for slowing migration is pervasive. In Rondônia, for example, which has the highest rate of population growth in the North, the annual rate of population growth fell from 15% over 1970-80 to 12% over 1980-85 and an estimated 7% over 1985-88. For the North, as a whole, the rate of growth of land in crops, cattle, and agricultural employment all slowed sharply between 1980 and 1985.

8. Nutrient Mining. Nutrient mining is the unsustainable extraction of nutrients from the forest soil through logging, cropping, and ranching. This process differs from agriculture (and silviculture) because it is fundamentally a mining activity--it requires that new land be constantly brought under production as nutrients are extracted in the forms of logs, crops, and meat. As a result old mined land is abandoned. The process of nutrient mining varies from region to region along the frontier, depending on the quality of soils, ease of forest access, availability of labor, credit, and land tenure relationships. Nutrient mining in the Amazon is a market response to an abundance of accessible Amazonian land generated by government road-building.

9. Classically, nutrients are extracted through a progression of activities that begins with logging (which often provides forest access), followed by annual cropping, and finally, ranching--after which the land is abandoned for an indeterminate period.[3] In some cases, the cropping stage may

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[3] Insufficient attention has been paid to secondary growth. A broad inventory of the nature of secondary growth in the Amazon and the conditions giving rise to it would be a key input in developing a more realistic assessment of both the economic and environmental futures of the Amazon.

be skipped, if, for example, soils are particularly poor and markets for low-grade timber (or charcoal) have evolved. The various stages of production may also be carried out by different actors. Land may change hands numerous times during the various phases of extraction, or the land may be exhausted under one owner as part of an integrated operation. In whatever specific form economic activity may evolve, the process is best understood as one tending to maximize the value of the nutrients mined, net of extraction costs.

10. As with any other form of mining, nutrient mining is not geographically sustainable--when nutrients are depleted beyond a profitably extractable level, the activity must relocate to a new area. Complete profitable extraction has generally taken on the order of 10-20 years, depending on the initial fertility of the soil. The perpetuation of this system depends on the continued expansion of the road system into new lands.

11. The Importance of Road Building. From the individual's point of view, nutrient mining is a rational approach to agriculture in a land-surplus (and land accessible) economy. Mining nutrients will emerge as the most competitive form of agriculture wherever new roads make land abundant (and cheap). The price of new land becomes a bargain if we compare the costs of fertilizer and chemical pest control required to sustain existing land with the natural fertility and relative absence of pests in new lands (especially after burning). With accessible land sufficiently cheap, it is more profitable to move the farm to the nutrient-rich, pest-free environment, than to import the fertilizers and pesticides to the farm. Similarly, in the timber industry, what are commonly viewed by northern forestry experts as wasteful logging practices are actually a rational response to a situation where land is cheap relative to labor. Whether a given farmer, rancher, or forester intends to remain (geographically) stable or not, economic forces will probably force him to adapt to a land-surplus economic environment./4

12. Local Support. Many frontier economies depend heavily on the activities that constitute nutrient mining. In these communities, proposals to adopt less profitable but more sustainable techniques find little local political support. The 10-20 year time period for nutrient depletion is generally beyond the time horizon of local decision-makers. Unless the underlying profitability of nutrient mining is altered, there are few people on the frontier with an incentive to see it ended.

13. Opportunity Cost to Brazil of Ending Deforestation. The value of agricultural production in the Amazon is very low--even ignoring possible external effects. In the last year for which regional value added statistics were available (1980), agricultural value added from the Northern Region was less than half a percent of Brazil's total GDP. Clearly, if local and regional environmental costs (damage to fisheries, sedimentation of reservoirs, and possible local climatic change) were deducted, the true net cost to Brazil of foregoing this agricultural production would be minimal, and many even represent a net benefit.

/4 For example, under economic pressure from labor shortage and low crop prices, farmers in Rondônia are uprooting tree crops, planted to provide a sustainable income, in order to establish unsustainable pasture.

14. The small value of the Amazon's agricultural product relative to Brazil's total GDP does not prevent these activities from being attractive to those currently engaged in them. Brazil's problems in controlling deforestation have more to do with the institutional and practical difficulties of modifying incentives and improving local law enforcement than they do with a national reluctance to forego Amazonian agricultural income. In addition there may be an important political cost to definitively ending Amazon expansion: whatever the reality, the myth that the frontier represents opportunity for those with the ambition and courage to seize it probably continues to defuse pressure for redistribution of wealth and income within the country.

15. Reasons to Control Deforestation. Although the opportunity cost of preservation, or reduced intensity of agricultural use, is low from a national point of view, the economic and political cost of attempts to enforce land use legislation throughout the Amazon could be prohibitive. Two reasons to reduce deforestation suggest a well-focused strategy, however. These are (1) to maximize the net (global) social benefits from information embodied in the genetic resources of the Amazon, and (2) to protect watercourses downstream from problems of siltation and sediment pollution resulting from upstream soil erosion.

16. Two additional reasons to be concerned about deforestation in the Amazon are: (1) the release of greenhouse gases from burning, and (2) the potential effects of forest cover loss on the Amazon's microclimate. A reasonable estimate of the contribution of deforestation in the Brazilian Amazon to the annual global production of new greenhouse gases over 1980-88 might be in the range of 1-2%. The potential to reduce these emissions is discussed below.

17. As part of its program of monitoring forest burning, INPE is tracking indicators of potential microclimatic change. Possible dangers should be evaluated using the INPE analysis along with data on changes in rates of burning and the nature and speed of secondary growth. The most important determinant of the microclimatic and watershed effects of land conversion will be the characteristics of secondary growth. Current models of microclimatic change must be improved to incorporate realistic assumptions concerning secondary growth, based on knowledge from field experience.

18. Potential for Trade in Greenhouse Gas Reductions. The market value of land in the Amazon is US$20-400 per hectare while the estimated economic value of carbon sequestered in a hectare of rainforest is US$1,300-5,700. This seems to indicate that if transaction costs can be overcome, there is scope for the rest of the world to pay Brazilians to leave land in the forest. The key to any trade would be the creation of local incentives to enforce a burning prohibition. An important advantage of a contract paying landowners not to burn, but leaving them full discretion with respect to other non-destructive uses of the forest, is that it would give landowners an incentive to search for non-destructive economic forest activities: e.g., indigenous activities, forest extractivism, or agroforestry. These in turn provide a presence that would assist in enforcement. The needs of local populations cannot be ignored, however. Any policy oriented towards reducing agricultural activity in the Amazon would have to support viable alternatives.

19. Managing Genetic Information. Biodiversity has an aesthetic and a scientific benefit. The aesthetic benefit can be expressed in the marketplace

accordingly. The scientific benefit, that of providing potentially important information for the cure of disease and the manufacture of products, is, however, poorly allocated in the marketplace. This is primarily because the owner of the land that provides the habitat within which genetic information will flourish will usually not benefit from its discovery and eventual application.

20. The value of the genetic information of the Amazon can be maximized through a combination of study and preservation. Studies of island biogeography have established that, as a rule of thumb, when the area of (contiguous) habitat is reduced by a factor of 10, the number of species in the area is halved. This ratio suggests that information loss can be kept to a minimum through adequate planning and early identification of those species threatened with extinction due to habitat loss. The creation of the needed reserves and research effort will require international support, however, with special attention being given to mechanisms to ensure that Brazil benefits from the system.

Policy Recommendations

21. An environmental and developmental strategy for the Amazon should include the following main elements:

(a) a policy to regulate forest access;

(b) the elimination of policy-induced (price) distortions that favor deforestation;

(c) a policy to identify and preserve special areas.

In addition, pilot market-based policies should be used to create local incentives for preservation and permit the rest of the world to compensate Brazilians for foregoing crop production and ranching in the Amazon.

22. Control Forest Access. The first order of priority is a policy to control forest access. The provision of access to new land is the most environmentally important government activity in the Amazon. The reality and the perception that new lands will be continually opened is fundamental to the viability of nutrient mining. Once the perception that accessible land is scarce becomes reflected in land markets, sustainable agricultural techniques become competitive./5

23. The policy challenge, therefore, is to reconcile Brazil's interest in rational exploitation of her resources with the importance to the rest of the world of reducing carbon emissions or protecting biodiversity. The basic approach should be that, first, any road must be economically justified by Brazilian benefits that also incorporate environmental costs, and, second, the

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/5 It is likely, however, that in many areas of the north, agriculture would not be economically viable without cheap new lands.

rest of the world should pay for non-Brazilian benefits.[16] This requires (a) that the objectives of building a road be clearly stated, and the route and technique that maximize net benefits (including domestic externalities) be identified; (b) alternatives be identified that provide Brazil the same benefits, but at a lower global cost; and (c) the global incremental benefit/cost of these alternatives be evaluated as a complementary internationally-financed project. If the benefit/cost of the environmental increment to the road project in Brazil is high relative to alternatives elsewhere, the world should pay for the incremental costs.

24. Eliminating Policy-Induced Price Distortions. Historically, government has intervened strongly in agricultural product and credit markets in Brazil. Some of these interventions were oriented specifically toward encouraging agricultural activity in the Amazon. Others had a more indirect effect through their tendency to favor large farms and labor-displacing agricultural technology elsewhere in Brazil, thereby increasing the potential pool of rural migrants. Most of the programs listed below have become substantially less important over the past several years, due both to government recognition of the need for reform and the pressure of budgetary constraints. Nevertheless, the extent to which they continue to distort incentives, produce negative environmental effects, and waste government resources should be reviewed, and appropriate changes made. The policies include the following:

(a) Price and tax policies that create incentives for agriculture in the Amazon:

  (i) agricultural commodity price supports;

  (ii) uniform fuel pricing policies; and

  (iii) subsidized credit, especially from regional incentive schemes.

(b) Policies that increase migration to the Amazon by displacing rural labor in other states through subsidies for land-using and labor-saving technologies or land uses:

  (i) differential tax rates tending to increase the north-south land price gradient;

  (ii) farm commodity price supports that favor large-scale producers over operators of smaller units;

/6 Mechanisms are becoming available to finance global benefits. The UN Global Environment Facility is one such mechanism. There are also precedents, such as the case of the energy utility in The Netherlands that was permitted to avoid costly pollution control costs at home by investing in pollution control in Poland and in tree plantations in Latin America. The European Commission has pressed member states to accept a commitment to stabilize carbon dioxide emissions by the year 2000. UK economists have estimated that a carbon tax designed to freeze carbon emissions in the industrial sector would need to be set at US$25-50 per ton of carbon. With European firms facing this type of pressure, lower-cost mechanisms for reducing carbon emissions in developing countries will probably gain in popularity.

(iii) subsidized credit; and

(iv) not controlling inflation, a failure which increases the demand for land as a store of value.

25. Identify and Protect Special Areas. A successful policy intended to preserve special areas (parks, biological reserves, indigenous reserves) must reduce the local benefits from burning, and increase local incentives to enforce land use restrictions. The most effective way to do this has been discussed above--to ensure that new roads do not create incentives to violate the land use restrictions. To make the roads policy consistent with the reserves policy requires significantly stronger action than merely outlawing road building in reserve areas. It also requires assurance that new roads not lead to increased illegal activity within reserve areas. The purpose of such a test would be to avoid roads which, despite not actually being in reserves or special areas, nevertheless increase the incentive to invade them.

26. This could be formalized with the following litmus test for new infrastructure:

(a) The infrastructure must pass an economic cost/benefit test based on legal activity only; and

(b) The road must generate the fiscal resources necessary to finance the increased enforcement (or other measures) needed to control illegal activities. In the short run, it may be sufficient control if legal activities were simply made absolutely more profitable than illegal activities. Over the longer term, however, capital and labor would find their way into (less) profitable illegal activity also, and enforcement would be required.

27. The Brazilian government has designated over 1 million km^2, approximately one fifth of the Legal Amazon, as either reserves or parks. In practice this designation has little meaning, however, since these areas receive minimal protection. A comprehensive study of Brazil's conservation areas found that, at present, there is approximately one park guard per 6,161 km^2 of parks and reserves./7 In addition, IBAMA has legal title to none of the 8 National Parks, and to only one of the 8 biological reserves in the Amazon./8 The National Environmental Plan proposes a regime which would provide one park guard per 394 km^2 of conservation units. The national parks would remain with 5,188 km^2 per guard. Indian areas have even less protection.

/7 By way of comparison, Butler (1985) reported that CONSAG, the company that ran the Tucama colonization project in Pará, had a security force which in 1981 numbered 40 men plus several jeeps and a small airplane for surveillance of its 4000 km^2 holding.

/8 IBAMA also has legal title to 40% of a second biological reserve (Lago Piratuba).

28. Recently, a major initiative was launched to identify Amazonian areas that are especially rich in biodiversity.[9] Data are not yet available to provide a systematic comparison between current Park and Reserve status of land and its preservation priority.

29. In sum, parks and reserves currently lack effective protection and clear tenure arrangements, and have unclear correspondence with biological criteria. Under these circumstances, a realistic reappraisal of the size, location, and priorities of protected areas is called for, including an assessment of the policy tools that are appropriate for each. Especially important are access policies (discussed above) and buffer zone policies.

30. Highly selective zoning, designed to create buffer zones around (or in) parks and reserves could possibly play a role in stabilizing agriculture and protecting reserve areas. Supporting policies would include (1) reducing financial incentives to deforest (as reviewed above), (2) developing viable and stable agriculture packages, and (3) strengthening enforcement and increasing participation by groups likely to favor enforcement.

31. Consider Market-Based Incentives. The potential role of market-oriented mechanisms in preventing socially harmful forest conversion should be explored. There are three major candidates--a burning tax, marketable burning permits, and outright land rental (for preservation). Land rental, with the owner being responsible for preservation, appears to offer the best potential. Control of conversion on public lands may require more complicated solutions, however, that provide local incentives to prevent encroachment. Alternative mechanisms are reviewed briefly below:

32. A burning tax has a number of drawbacks. First, even in the best of circumstances, tax enforcement in the Amazon is extremely weak or nonexistent. Second (as discussed below), even if the tax were collectable from landowners in the Amazon, it would lead them to abandon their ownership to squatters. Third, such a tax provides no mechanism through which the rest of the world can compensate Brazilians for reducing global negative externalities.

33. Taxing Amazon forest burning at a rate close to the current estimate of global damages would probably lead landowners to relinquish ownership responsibility--compounding problems of property rights and enforcement. The current best estimate of the present value of future global warming damages from burning a hectare of dense tropical forest is around US$2,200 per hectare. These damages greatly exceed the price of land on most of the Amazonian frontier. Including a burning tax equal to the marginal cost to society would make land

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/9 This initiative, which convened scientists from around the world, was funded largely by the W. Alton Jones Foundation, and World Wildlife Fund, and involved the cooperation of IBAMA, INPA, the New York Biological Garden, Conservation International, and the World Bank.

privately worthless./10 A landowner facing such a tax would find that the benefit of land ownership does not justify the costs. In the absence of alternative profitable uses of land, he would abandon his claim to title. The likely result over the long run would be that squatting would become the prevailing form of land tenure, and enforcement of the burning tax could not be linked to land ownership.

34. The low value of land in the Amazon relative to potential burning damages is a clear signal that there should be potential for trade between Brazil and the rest of the world involving payments not to burn. The major advantage of a payments scheme is that it creates local incentives to preserve the forest. A system of either tradeable use rights or rental contracts could be designed to (1) create incentives to preserve the forest, (2) reinforce land ownership and owner responsibility, and (3) provide a direct mechanism for material expression of international concern over Amazonian environmental damages. Possible problems of moral hazard would have to be considered and dealt with, however.

35. The effect of a payment not to burn on land values and owner incentives can be illustrated from the above example. With a 10% discount rate, a landowner should be indifferent about owning a hectare of land worth US$400 and an annuity of US$40 (because the present value of an infinite income stream of US$40 per year is US$400). This suggests that the landowner could be made better off by paying him annually any value over US$40 not to burn. Unlike the case of taxation, where enforcement would burden the public sector in a generally hostile local environment (increasing its costs and reducing its effectiveness), a subsidy not to burn would put landowners in the business of enforcement.

36. Because of their restricted and short-term contracts, neither scheme would be likely to be seen as a threat to Brazil's sovereignty, as would outright land purchases. NGOs, "debt for nature" arrangements, and other bilateral and multilateral organizations (such as the Global Environmental Facility) could be brought to participate either through concerted strategic programs or by acting independently.

/10 This assumes that, from the point of view of private profitability, the traditional pattern of logging, burning, agriculture, and livestock strongly dominates other uses of the land. If geographically sustainable agriculture or silviculture is only somewhat less profitable than techniques requiring burning, the value of land ownership may not be unduly affected and the tax would have the desired effect of encouraging landowners to switch to more environmentally benign land uses.

Table 1: SUMMARY EVALUATION OF POLICIES TO REDUCE ENVIRONMENTAL EXTERNALITIES IN THE AMAZON

Policy Area	Medium-Term Objectives	Measures Taken	Possible Additional Measures	Comments
Control Forest Access	Maximize the net global benefits of any new transport infrastructure in the Amazon. Compensate for any losses this might entail for Brazil.	None	• Improve Cost-Benefit analysis of future proposed infrastructure projects to include all calculable Brazilian and Global externalities of a range of alternatives. • Choose project with highest Global net benefits and compensate Brazil for any losses relative to the Brazilian social optimal project.	Constitutional reform has given lower levels of government more fiscal autonomy (at the federal government's expense). Future pressure for infrastructure development is likely to come from states and municipalities, not the federal level.
Eliminate Policy Induced Distortions	Eliminate distortions that "pull" immigrants into the Amazon.	• Funding for commodity price supports and subsidized credit has been reduced dramatically. • Subsidized investment to new cattle ranches has been restricted.	• Eliminate funding for programs in previous column. • Eliminate uniform fuel pricing. • Eliminate tax policies that favor agriculture and ranching. • Eliminate regional fiscal incentives. • Eliminate incentives favoring federal revenue sharing schemes for states and municipalities to encourage population growth.	• The minimum price program has the most important potential environmental effect. • The environmental effect of the uniform price policy is locally important, but may be either positive or negative. • Tax policies and subsidies to investment are probably relatively unimportant because of weak enforcement and strong incentives to divert funds to more profitable uses (e.g., the overnight market).
	Eliminate distortions that "push" emigrants from outside the Amazon.	Tax shelters favoring large farms have been reduced under the Collor plan.	• Eliminate policies tending to favor large farms and displace rural labor from other states (e.g., ethanol subsidies, agricultural tax shelters, differential access to commodity price supports and subsidized credit).	The rate of migration is slowing, due in part to the relative lack of success of previous migrants and the stabilization of the pool of potential new rural migrants. The rate of natural increase within the Amazon remains high, however.
	Reduce incentives for environmentally and economically wasteful "signalling" of land occupancy and/or ownership.	Burning of land is no longer accepted as proof of occupancy for purposes of obtaining land title.	Clarify the authority of the state, federal, and municipal governments with respect to land policy.	The low and temporary productivity of most Amazon soils may not support the emergence (or justify the creation) of institutions to establish and defend property rights. Current biological and indigenous reserves should receive top priority for delineation and enforcement.

Table I: SUMMARY EVALUATION OF POLICIES TO REDUCE ENVIRONMENTAL EXTERNALITIES IN THE AMAZON (contd.)

Policy Area	Medium-Term Objectives	Measures Taken	Possible Additional Measures	Comments
Preserve Special Areas	Protect indigenous groups and biological and extractive reserves.	Over one fifth of the Amazon has been designated as either a park or a reserve.	• Develop and implement a biodiversity protection plan; designate priority areas to be protected. • Ensure that new infrastructure does not increase incentives for illegal activity in reserves and parks. • Develop buffer zones around parks and reserve areas; create incentives for local enforcement of zoning regulations. • Explore market-based mechanisms to protect selected areas; e.g., land rental, taxes, or marketable land-use permits.	• Cloudy land tenure arrangements currently combine with weak local institutions to make local enforcement of reserve and park policy impossible. These weaknesses are exacerbated by taxes or restrictions that slow the demand for land ownership and erode the local economy.
Explore Market-Based Mechanisms	Bring landowners and others to consider social costs in their private decisions.	None	Tax the external (social) damages.	This is probably not feasible to implement in the Amazon. If enforceable, effective taxation of burning at marginal global warming costs would end burning for agriculture in the Amazon.
			Consider a system of marketable burning permits.	Implementation of marketable burning rights, with an allocation that did not make landowners worse off, would be more feasible than a tax--but is still probably not a realistic option.
			Consider renting land with owners responsible for preservation.	• Current land values and rental rates suggest that landowners could be paid enough to be made better off than they are currently, while still making Amazonian carbon sequestering cheap relative to controlling greenhouse gas emissions from other sources. • Incentives would have to be found to give the local community a stake in preventing encroachment on public lands.

COMMENTS FROM THE BRAZILIAN GOVERNMENT AGENCIES

An earlier draft of this report was sent to the Brazilian Government in June of 1991. Comments were received in February of 1992 and discussions were held in Brasilia on March 24, 1992. Partly, these comments have been addressed in the present text. But since the comments are numerous, and could not be incorporated adequately through short references in the main text, they are presented here in a separate section. The comments' paragraph references have been changed to correspond to the current draft.

Observations and comments by Brazilian Government Agencies

I. General Comments

1. Regarding general comments, we will deal with the following aspects:

(a) the implications of not taking as a reference the concept of sustainable development;

(b) the treatment given to fiscal incentives;

(c) the question of deforestation and forest burning;

(d) the possibility of "sustainable activities" in the Amazon region; and

(e) the Grande Carajás Program (PGC), environmental legislation and World Bank OED Reports.

A) The implications of not taking as a reference the concept of sustainable development.

2. The starting point is that any solution to the problem of deforestation in the Amazon, even when it combines ecological and economic considerations, will only be viable at the local level insofar as it explicitly includes the needs and expectations of directly affected local communities. This problem must include the social dimension, centered on the poverty typical of under-developed regions. It is almost meaningless to consider the quality of life, aesthetic values of nature, or even the importance of the rainforest's long-term economic potential, when the deterioration of the rainforest and other natural resources is associated with the populations' struggle for survival. In this context, solutions to deforestation and other environmental problems require the identification of strategies for long-term sustainable development of the region, including both environmental needs as whole and the more immediate needs of local communities.

3. Among the merits of the concept of sustainable development are the search for a balance between global and national/regional dimensions of environmental problems; recognition of the linkages between the environment and under-development, recognition of the need for qualitative changes in economic relations, especially among developed (industrialized) countries and under-developed countries (the majority still being primary-exporters); recognition of the need for greater cooperation among countries in the specific field of environmental questions; and giving a more equitable view in environmental cost and benefit distribution among humanity as a whole, societies on a national level, and the most directly affected communities.

4. The concept of sustainable development is rejected by the author due to its imprecision (see paragraphs 70 and 71). However, the concepts of stable and transitory activities used in the report clearly present a bias with regard to environmental needs at the expense of other dimensions, such as, for example, the development needs of local populations. On this point, it is necessary to consider that most extractive populations (environmentally more suitable activities) are on the outer edge of most benefits of development: Brazilian society and humanity as a whole have reaped benefits from preserving a considerable part of the Amazon rainforest at the expense of the poverty of these populations.

5. The lack of a global view on environmental questions in the Amazon (within the context of the economy and international economic relationships) and even of a national view, leads to unacceptable generalizations, among these: a) the classification of Amazonian agriculture as "nutrient mining" - in any region of the world and at any time in history, this type of activity was always denominated agriculture (evidently ultra-extensive and extensive); b) the particular view of annual agriculture - it should be pointed out that "itinerant agriculture", commonly practiced in the Amazon, may be sustainable over the long term under specific conditions (which is ignored in the document); c) the generalization of this qualification for all annual agriculture in the Amazon is incorrect - see for example várzea cropping and fertilized crops; d) the generalization that all cattle-ranching is predatory - it should be pointed out that cattle-ranching practiced on native and várzea lands does not deserve such a characterization e) the characterization of perennial crops as "transient" activities - this fact is completely incompatible with the reality of these crops in the Amazon (see for example oil palm and cacao).

6. In summary, the lack of the use of the concept of sustainable development causes the proposed solutions to fail to incorporate the needs and expectations of local communities. There is a greater emphasis on the environmental dimension at the expense of the development of local communities. This fact greatly diminishes the possibilities for successful measures in favor of preserving Amazonian natural resources due to the low involvement of local populations.

7. It is necessary that the environmental problems in the Amazon be analyzed in light of the concept of sustainable development - on this matter the contributions of REPETTO (The World Resource Institute), BARBIER (the London Environmental Economics Centre), and BRUNDTLAND (The World Commission on Environment and Development), and the United Nations Program for the Environment (PNUMA), among others, are very illustrative - in reality ecological needs should be reconciled with the economic and social view in the use of natural resources.

B) Treatment given to fiscal incentives

8. The analysis of the impact of fiscal incentives on the environment in the Amazon reflects a policy not applied since 1988. The attribution of fiscal incentives to agricultural projects was suspended for the first time in

1988, among other government measures taken under the "Nossa Natureza" Program launched by the Federal Government that year with a view to protecting the Amazon environment and, in particular, the tropical rainforest. In March 1990, under the stabilization policy launched by the Collor government, fiscal incentive instruments were suspended, this time for all types of projects.

9. The incentives policy revived starting in 1991 is totally different from that previously applied, a fact that does not seem to be reflected in the report.

10. The fundamental difference of the new incentives policy in relation to the previous one is due to:

(a) Under the terms of Decrees N°s 101 and 153, of 1991, regulating the new fiscal incentives law, these may not be awarded to localized enterprises in primary ecosystem areas where there are social tensions, Indigenous areas or areas still not subject to ecological-economic zoning or pre-zoning (zoning underway);

(b) Under the terms of the same legislation, the money previously allocated to enterprises as fiscal incentives (and which resulted in preferential treatment to the owners of these enterprises), were transformed into debenture bonds. In accounting terms, this meant that half of the capital of these enterprises changed from non-callable liabilities to callable liabilities; a capital subscription became a loan. This transformation, in practical terms, implies an ever-decreasing interest by investors (contributors to the income tax and potential beneficiaries of fiscal incentives) to embark upon enterprises in the agricultural sector, but to increasingly divert their investments to other activities (industries, tourism or basic services), with lesser impact on the forest.

11. Although deemphasized relative to demographic dynamics, the impact of fiscal incentives on environmental deterioration in the Amazon is still overestimated: first, because in territorial terms fiscal incentives were applied in an area corresponding to less than 0.8% of the Legal Amazon (something like 10% of the region's effectively occupied area); second, because the larger concentration of enterprises is located in savannah ("cerrados") or "várzea" areas, since it is recognized that forest areas on solid ground are of anti-economic use for agro-grazing purposes; third, because the data presented in Table II-4 (US$3.17 billion), regarding funds applied in the region's cattle-raising, collected by the Central Bank of Brazil, exceed those known by SUDAM, the agency effectively in charge of managing these funds.

C) <u>The Question of Clearing and Burning</u>

12. With regard to estimates of forest clearing in the Amazon, the disparity of data presented is noted. The use of burning as an indicator of clearing of new areas in the Amazon presents some difficulties, one of them

being that burning does not always represent new clearing. It should be remembered, in this sense, that the practice of burning is common in pasture areas as a means of managing them against insect pests. Besides, with regard to small farmers practicing traditional rotating agriculture, burning may be occurring both in new primary forest areas and in secondary forest areas with different cycles and ages. The doubt lies in whether radiometric measurements available until now can capture these differences so precisely, with a view to a more reliable estimate.

13. The estimates from different sources presented in the document show unmistakably the difficulties in making a more consistent estimate of clearing (or of altered areas) in the Amazon. Thus, for example, the comparison of lesser and greater clearing estimates for the classic Amazon shows a 66.8% difference. If the Legal Amazon is considered, estimates still have a 67.3% difference, between greater and lesser value. These estimates are even more fragile when compared within a single state: in the case of the State of Acre the difference is 185.7%; for Roraima, 100%; for Rondônia, 100%; and for the State of Amazonas, around 960%. Only the estimates for the States of Pará and Amapá have smaller discrepancies. Besides this, these estimates of altered areas, when compared with Agricultural Census data, create even more doubts. For example, if we consider altered areas as part of total areas presently occupied by agricultural establishments in the Amazon, and add native areas - the great majority used without much environmental modification - this would give a remaining non-altered forest area of about 20% in relation to total lands already occupied by agricultural establishments. This coefficient places in doubt the current estimates from satellite images. The question here is not the occurrence or non-occurrence of large-scale clearing in the Amazon, but the need to make stronger estimates, especially in the sense of seeking greater credibility which is considerably jeopardized by such discrepancies.

D) Possibilities of "sustainable activities" in the Amazon

14. We have already dealt with distortions from not using the concept of sustainable development in relation to the classification of agricultural activities in the region such as nutrient extraction. In truth, these are extensive or ultra-extensive systems, typical of the first phases of occupation of agricultural frontier areas, like all over the world and at different times in our history. Besides, not all Amazonian agriculture deserves the qualification of nutrient extraction. In this regard, the cultivation of annual species is fundamentally different from that of perennial species; and both differ from cattle raising. Far from being nutrient extraction activities, such as black pepper, oil palm and cacao, despite substituting the original forest cover, they refute the idea of soil predators. Comparing the volume of nutrients removed almost systematically, an improvement in the chemical conditions of the soils can even result, as occurs, for example, in areas planted with black pepper in Tomé-Açu/PA. It should be remembered that even perennial crops without intensive use of fertilizers have shown good long-term sustainability.

15. In the case of annual crops - the majority in itinerant systems - it is necessary to consider at least two points: one, the intensity of agriculture practices; that is, what is the volume of harvests/year (measuring the intensity of removal of soil nutrients) which is closely tied to market production; and two, the initial quality of the natural resource (soil) on which one is working. Certainly, such conditions are very different throughout the Amazon. Both nutrient extraction levels through harvests, and the initial stock of nutrients and the speed of their replacement by geological processes, are also very different, resulting in balances or soil nutrients in annual farming systems - the most aggressive farming system - are given in more traditional systems (without use of fertilizers), through the combination of the following variables: the intensity of nutrient removal through harvests; the initial stock of nutrients in the soil; and the natural recycling period for nutrients (through vegetation). Thus, in small harvest conditions (only for subsistence), the balance of soil nutrients can be obtained over a relatively prolonged fallow period (12 to 20 years) for bushes and trees, since there are no pressures on this process (which increases both the area used, and the intensity of harvesting by area). In this context, the existence of local markets for these products aggravates the process, while the initial soil nutrient stock conditions (for example, rich red soil) reduce this process.

16. With regard to itinerant agriculture, one should remember that regeneration of secondary vegetation is a natural and very efficient form of nutrient recycling. Whether or not soil fertility deteriorates depends essentially on the crop cycle and fallow period. 10 to 20 years after a short crop cycle, soil nutrient stocks can be replaced without much problem. Perhaps the most important question here is that soil has life, and therefore it is improper to speak about an initial nutrient stock that becomes depleted through use, as occurs in mineral extraction. It is necessary to consider the dynamics of nutrient recycling through secondary vegetation. There is no scientific basis for the use of the term "mining" to designate itinerant agriculture as the Report does.

E) Grande Carajás Program - PGC, environmental legislation, and World Bank OED Reports

17. The report also presents controversial points as definitive, generating unfavorable expectations without contributing to a realistic analysis of the situation.

18. One of these points refers to the region of the Grande Carajás Program (PGC). The text is not up-to-date in relation to progress made over the last two years in government policies for the region, especially with regard to the previously approved steel sector. For the sake of impartiality, mention could be made of the statements made by the Secretariat of Regional Development to IBRD in August 1991, in reply to the Ferro-Carajás Project impact report, prepared by OED/IBRD, referred to in the document presently being analyzed.

19. There is a need to incorporate into the discussion process for Report N° 9104-BR, the comments previously prepared by SDR on OED Reports: "ENVIRONMENTAL ISSUES AND CONSEQUENCES OF THE POLONOROESTE PROGRAM", and "THE WORLD BANK AND THE ENVIRONMENT IN BRAZIL: A REVIEW OF SELECTED PROJECTS", contained in letters SDR-PR/DPA/N°s 107 and 108/91 (copy attached), considering that the three reports deal with the same area - the Amazon.

II. SPECIFIC COMMENTS

20. Paragraph 43 - Deforestation cannot be used as the only indicator of environmental problems in the Amazon. On this matter, it should be remembered that a perhaps more serious question for local populations is water contamination by gold-diggers in the beds of Amazon region rivers (which does not depend on clearing), since these populations use the waters for various purposes and also consume fish from these waters without any health controls. Besides this, in many areas, gold-digging is more important than deforestation in terms of contributing to silting of the region's rivers.

21. Paragraphs 12 and 13, the term deforestation was always criticized by specialists, rightly so, since the term "alteration of vegetation cover" would be more appropriate. Regarding this estimate, it is necessary to define natural fields, savannahs, land covered by secondary growth, cities, bodies of water and forests.

22. Page 4, Table I-1 - The English term for savannah should be corrected. The characterization of savannah is that of always having a grassy cover. The text should be corrected. Instead of 6% of Brazil, the Legal Amazon represents 57.73%, or 60% of the country's territory in rounded numbers. In general terms, not including small formations considered ecological enclaves and refuges, and based on the work of the RADAMBRASIL Project, the distribution of vegetation in the Legal Amazon is the following:

- Dense forest - 1.997.348 km_2
- Open forest - 1,071,643 km_2
- Semi-deciduous forest - 62,840 km_2
- Deciduous forest - 67,683 km_2
- Savannah - 709,760 km_2
- Natural fields - 60,050 km_2
- Forest/Savannah transition - 759,532 km_2
- Mangrove forest - 120,939 km_2
- Campinas - white sandy soil, on the upper Rio Negro in Amazonas State - 57,756 km_2

23. Page 5, Table I-2 - The data should be corrected, based on the INPE/INPA Report of August 1990, as follows:

- Amazonas - 18 km_2, instead of 10 km_2
- Pará - 88 km_2, instead of 128 km_2
- Legal Amazon - 264 km_2, instead of 358 km_2

24. Paragraph 14 - Below the table, on the first line, the technically correct term is "image interpretation" and not "photo interpretation", when orbital images, rather than photographic images, are interpreted. It is not necessary for the image to be colored in order to distinguish secondary from primary forest. The reflectance, therefore, a signature of vegetation, is different in the two situations and may be identified by forestry specialists without remote sensing. There is no problem in identifying exploited areas mechanically.

25. Paragraphs 29-36, - The attempt to explain the reasons that controlled the evolution of land prices during the 1970s and 1980s, is not very convincing. Besides, we have reservations with two aspects of the procedures: (a) crediting price performance in 1986 to the Bresser Plan; (b) the uncritical use of the IGP-DI as a deflator during this period.

26. Paragraph 37 - The mechanical relationship established between increased demand for food in the region's cities and a supposed increased agricultural profit in the northern region, seems overly simplistic.

27. Executive Summary paragraphs 13 and 14 - The opportunity cost of deforestation, as addressed in the document, is unacceptable to Amazon communities. Any calculation in this sense should incorporate subsistence costs for local populations: local populations have as much right to the benefits of development as the rest of Brazilian society.

28. Paragraph 48 - The footnote brings up the question of the treatment of the Amazon region as a whole, an issue already mentioned in the general review. The same care should be taken in the parts of the document that deal with local and economic issues.

29. Paragraph 61 - For purposes of fairness, the carbon emission/t costs in the atmosphere need to be contemplated according to the contribution of countries to the volume of pollutants emitted. Certainly, the "greenhouse effect" is a large component in relation to the stock of gases emitted over the years. Any control now or in the future should consider this dimension. The argument is that one ton of carbon dioxide emitted in the Amazon region cannot be treated in the same way as one ton of carbon dioxide emitted by industries in Europe, the United States or Japan - which began polluting more than two centuries ago. The non-inclusion of this consideration may lead to the perpetuation of the present global situation, development problems and consequently pollution, which is unacceptable for non-industrialized countries.

30. Paragraph 60 - It is important to consider that a simple, generalized prohibition of fires in the Amazon means, in general terms, no farming. An answer should then be given to the question that this raises: what kind of life do we want for directly affected populations?

31. Paragraph 58 - Again the use of data on modification of vegetation cover, without stratifying it in various segments, and without subtracting those referring to cities, highways and bodies of water, leads to erroneous calculations with regard to carbon gas emission. This is due to the difference of biomass in different biomes. Thus, the 3% estimated contribution should be viewed as a mere exercise requiring more detailed studies that take the specific bio-mass into consideration.

32. Paragraph 60 - These conclusions should be analyzed in light of the previous comment.

33. Paragraph 67 - While, in general, the differences are accepted, the declivity of soils and the size of areas used for agriculture, define the level of erosion and sedimentation. In the case of the Bragantina zone, in the State of Pará, by far the oldest colonized area in the Amazon region, it has clear rivers and streams, even during rainy seasons. It should be added that this area is the main supplier of agricultural products in the State of Pará.

34. Paragraph 68 - Article 1 of the Brazilian Forest Code, Law N° 4.771 dated 9-15-65, had already defined permanent preservation areas for springs and rivers.

35. Paragraph 70 - The premise of geographically stable activities as being supposedly sustainable, does not seem correct to us, since the concept of sustainability does not apply to an isolated geographic area but does apply to land as a whole, where all are co-responsible. This point should be reviewed by the World Bank.

36. Paragraphs 74 and 75 - Sustainable development as stated in the Brundtland Report is a fundamental question for the Amazon region, as well as for the world. Because it suggests a new world economic order, certain sectors have opposed its adoption.

37. Paragraphs 70, 73 and 74 (Editor's Note: paragraphs 71 and 72 added in current draft) - The use of the adjective "sustainable" throughout the document was very confusing. In these paragraphs, after establishing the conceptual differences that the word acquires in different scientific disciplines, it is announced that the term will not be used. However, on the following pages the term appears at least a dozen times in the most varied contexts, but never in the sense adopted by the Brundtland Report and accepted by the World Bank (cf, note 26, p. 25). This question should be better clarified in the text. If not, we will return to the level of confusion that the report began to dispel.

38. Paragraph 76, footnote 29 - Land ownership title became fundamental in the Amazon as a pre-condition for access to rural credit and fiscal incentive policies. Furthermore, land became a very important reserve of value in the 1980s, with successive economic de-controls following the failure of the Cruzado Plan.

39. Paragraph 76 - An analysis should be made of the level of knowledge of Amazonian peasants, the majority of whom are unaware of techniques for well-managed farming. Rural assistance conditions in the Amazon region are precarious, and this interferes with proper soil management. Thus, it is not only the forces of the market and costs that interfere with the system, but also illiteracy, a consequence of poverty in the region.

40. Paragraph 76 - Footnote 30 refers to the study by Ester Boserup, 1965. It is stated there that the main conclusion of the author establishes a direct relation between the adoption of more intensive techniques and the shortage of land. This statement does not correspond to Boserup's thesis and this type of distortion of her thinking could create much ambiguity. To save words, a quick comparison with note 74 (paragraph 297), where the question is put more properly, is suggested. There it is clear that the author links agricultural intensification to demographic pressure and not to shortage of land.

41. Paragraph 79 - In this paragraph, the classification adopted throughout the document for the region's main productive activities, appears. And it does not seem appropriate because it ignores many relevant issues. For example: (a) Is it possible to state that all types of cattle ranching and small-scale farming are geographically unstable? It may be true for Rondônia, but certainly not for many regions in Maranhão and Pará. (b) Can black pepper planting in Pará be considered under the category of small-scale farming? If so, what scale was used? (c) The constant opposition in the report between these two agricultural categories (cattle ranching and small-scale farming) is extremely ambiguous. Many times it can be easily perceived that, behind these denominations, there exist, in reality, types of family farming and corporate ranching and that these do not always correspond to significant differences in terms of size. Furthermore, the report ignores the existence of cases of corporate farming which are not small at all... (d) Even putting this tremendous ambiguity aside, and temporarily accepting the category of small-scale farming, it should be asked whether it is possible to place in the same basket a large mass of peasants still only weakly integrated into product markets and production factors, and modern, multi-cropping family farmers using irrigated perimeters, for example. The list of answers could be quite long. The purpose, however, is only to indicate that the typology adopted to identify agents is too rough, at least with regard to agriculture. And this evidently jeopardizes the report's generic conclusions on the socio-economic and environmental performance of the agents.

42. Paragraph 79, Table II-1 - Agriculture and other cattle raising - should be added to savannah. The area flooded by Amazon region hydroelectric plants is 5,445 km2 (INPE/INPA). The area under modified vegetation cover in

the accepted Legal Amazon is around 400,000 km2, while the sum of all the areas in the table reaches 600,000 km2.

43. Paragraph 80, Table II-2 - The data that appear as being from the 1985 Agricultural Census, are still the results of the Preliminary Synopsis; and those referring to 1987 are the so-called "consensual statistics" based on estimates by FIBGE local agents. Therefore, they are not comparable to the others. This may perhaps explain the high growth rates obtained in the last column of Table II-2. (Editor's Note: the 1987 column was deleted in the current version of the report).

44. Paragraphs 123-126 - With regard to improved techniques for forest exploitation and management, the document does not consider the work begun in the 1970s between IBDF (now IBAMA) and SUDAM for forest management and sustained exploitation, carried out in the Tapajós National Forest. Since then, experiments installed at that time are being followed up, and are presently under the sponsorship of EMBRAPA. These works currently show complete results on the feasibility of forest management and exploitation in the region. Enterprises such as JARI, among others, have used these results for managing their forests. Furthermore, other experiments implemented at the same period, presently consisting of nearly mature systems, present data on secondary forest management and enrichment, with good perspectives. All these works should be examined.

45. Paragraph 124 - The same conclusions are made by EMBRAPA and SUDAM in experiments carried out at the Experimental Station of Curuá-Una/SUDAM in Santarém, Pará, and at the Tapajós/IBAMA National Forest in Santarém, Pará. There are various publications on this subject.

46. Paragraph 126 - An in-depth study of this point, considering research at the SUDAM Experimental Station with 36 years of experiments begun by FAO experts in 1954, and studies by EMBRAPA, INPA and FCAP, would provide information on procedures to be adopted for native forest exploitation and management in the Amazon region.

47. Paragraphs 137-139 and following - The prohibition on exporting logs to other countries is maintained and, starting at 3 inches, only small lots can be exported up to 10% of the total shipment. The various state laws prohibiting the export of logs to other states have been abolished by the Supreme Court (STJ) because they were unconstitutional.

48. Paragraph 287 - Although it is the main factor, the need to review data in accordance with vegetation typology is reiterated.

49. Paragraphs 170-173 - The object of these four paragraphs - agricultural research and extension - deserves much more prominence in this type of report. Everything indicates that the possibilities for the evolution of a large part of the region's agriculture toward sustainable forms of production, both from economic and ecological viewpoints, will depend on an immense effort in these areas.

50. Paragraphs 222-247 - The report is right in using caution in dealing with the question of extractive reserves. However, in this case, it does not reflect the level reached by debates by the Brazilian scientific community. A check of the annals of recent SOBER and ANPEC congresses would help to improve treatment of this problem.

51. Paragraph 307 - The countries most responsible for atmospheric pollution since the Industrial Revolution have not reached an agreement on the emission of polluting gases. The USA's understanding is that the fact is not well-proven scientifically, and that each country should be free to decide which gas should be reduced and which should complacently be released according to their respective economies, besides considering it expensive to control emissions. Why, then, should a developing country be asked to unilaterally control its emissions?

52. Paragraph 323 - The weak correlation between areas presently slated for preservation and areas that should be given priority for preservation, can be explained by the biases dominating the evaluations and zoning carried out until now in the region. With few exceptions, areas slated for preservation mainly followed the criteria of "fragility" or "unsuitability" for agriculture on various management levels.

53. Paragraph 321, Table III-2 - The inclusion of Indigenous areas as protected areas distorts reality, and gives the feeling that the extension of areas as Conservation Units is large. This is not true when dealing with Indigenous areas.

54. Paragraph 327 - Zoning should be based on knowledge of what exists and what is the best way to use these resources, including their preservation. Any policy for the Amazon should be based on this pre-requisite. Otherwise, it would be no more than a make-believe policy exercise, such as, for example, the three directives proposed in the paragraph.

55. Paragraph 333 - The creation of pre-existing non-conforming use of zones is highly controversial and not applicable in all Conservation Units. Therefore, it should not figure in the document as a general criteria. Besides this, the effects of this type of policy are often the opposite of those pointed out in the document.

56. Paragraph 334 - Zoning is only the basis of the work. Instruments for zoning should consider what was defined based on field surveys. Policies and incentives, considering the level of education and local poverty, are what should change existing conditions.

57. Paragraph 339 - For the first time the report points out the influence of biomass on carbon dioxide production. Attention is drawn to recalculating gas emissions based on the various "facies" biomes involved.

58. Paragraph 348 - Presently, IBAMA only grants permission for clearing and burning of remainders of crops and pasture upon proof that half of the area was duly registered, with the assurance that permanent

preservation areas will be respected by the heirs and successors of the land owners. Proof of burning without IBAMA's permission results in heavy fines.

59. Paragraph 360 - Although progress has been achieved, U.S. resistance to adherence to the polluting gas reduction program, proposed chiefly by the EEC countries, is noted.

60. Paragraph 361 - "The Role of Native Forests in the International Timber Market". In this item, the extremely important role of the development of technological research on little-known and unknown woods, defining techniques for better use of woods, is not mentioned. This is one of the correct ways of seeking to decrease pressure on native forests. This point should be considered because of its extreme importance.

LIST OF ABBREVIATIONS AND ACRONYMS

ALBRAS	-	Alumínio Brasileiro S.A. (Brazil Aluminum)
ALCAN	-	Alumínio do Canadá (Aluminum of Canada)
ANPEC	-	Associação Nacional de Pós Graduação em Economia (National Association of Graduate Economics)
BASA	-	Banco da Amazônia S.A. (Amazon State Bank)
CEDEPLAR	-	Centro de Desenvolvimento e Planejamento Regional (Center for Regional Development and Planning)
CEPLAC	-	Comissão Executiva do Plano da Lavoura Cacaueira (Executive Commission of the Cacaueira Work Plan)
CFP	-	Companhia de Financiamento da Produção (Agency for Production Financing)
CIAT	-	Centro Internacional da Agricultura Tropical (International Center for Tropical Agriculture)
CPT	-	Commissão Pastoral da Terra (Rural Land Commission)
CVRD	-	Companhia Vale do Rio Doce (Federally Owned Mining Corporation)
DNEHSA	-	Divisão Nacional de Ecologia Humana e Saúde Ambiental (National Division for Human Ecology and Environmental Health)
DNPM	-	Departamento Nacional de Produção Mineral (National Department for Mineral Production)
ELETRONORTE	-	Centrais Elétricas do Norte do Brasil S.A. (Federal Power-Utility Holding Company's Subsidiary of Northern Brazil)
EMATER	-	Empresa Estadual de Assistência Técnica e Extensão Rural (State Enterprise for Technical Assistance and Rural Extension)
EMBRAPA	-	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
EMBRATER	-	Empresa Brasileira de Assistência Técnica e Extensão Rural (Brazilian Enterprise for Technical Assistance and Rural Extension)
FAO	-	Food and Agriculture Organization, United Nations
FGV	-	Fundação Getúlio Vargas (Getúlio Vargas Foundation)
FINAM	-	Fundo de Investimento da Amazônia (Development Fund for the Amazon Region)
FUNAI	-	Fundação Nacional do Índio (National Indian Foundation)
IBAMA	-	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (Brazilian Institute for the Environment and Natural Renewable Resources--Ministry of the Interior)

IBDF	-	Instituto Brasileiro de Desenvolvimento Florestal (Brazilian Institute for Forestry Development--formerly part of the Ministry of Agriculture)
IBGE	-	Instituto Brasileiro de Geografia e Estatística (Brazilian Statistical and Geographical Institute)
ICOM	-	Instituto de Comercialização do Sul (Institute for Commerce--South Region)
ICOMI	-	Indústria e Comércio de Minérios S.A. (Mining Industry and Business Enterprise)
IGP-DI	-	General Price Index, Domestic Supply
INCRA	-	Instituto Nacional de Colonização e Reforma Agrária (National Institute for Colonization and Land Reform)
INPA	-	Instituto Nacional de Pesquisas da Amazônia (National Institute for Amazonian Research)
INPE	-	Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research)
IPEA	-	Instituto de Planejamento Econômico e Social (National Economic and Social Planning Institute)
IPI	-	Imposto sobre Produtos Industrializados (Tax on Industrial Products)
IR	-	Imposto de Renda (Income Tax)
ITERPA	-	Instituto de Terras do Pará (Estate of Pará Land Institute)
MBP	-	Marketable Burning Permit
MIRAD	-	Ministério da Reforma Agrária e do Desenvolvimento (Ministry for Agrarian Reform and Development)
MRN	-	Mineração Rio Norte (Rio Norte Mining)
MT	-	State of Mato Grosso (north)
MS	-	State of Mato Grosso do Sul (south)
NAAC	-	Nippon Amazon Aluminum Company
NGO	-	Non-Governmental Organization
OED	-	Operations Evaluation Department, the World Bank
PCF	-	Paralelograma de Cobertura Florestal (Forested Area)
PDRI	-	Programa de Desenvolvimento Rural Integrado (Integrated Rural Development Program)
PGC	-	Programa Grande Carajás (Greater Carajás Project)
PHRHN	-	Population Health and Nutrition Division, the World Bank
PIN	-	Programa de Integração Nacional (National Integration Program)
PND II	-	Programa Nacional de Desenvolvimento II (Second National Development Plan)
PND	-	Plano Nacional de Desenvolvimento (National Development Plan)

PNRA	-	Plano Nacional de Reforma Agrária (National Plan for Agrarian Reform)
POLONOROESTE	-	Programa de Desenvolvimento Integrado do Noroeste do Brasil (Northwest Integrated Development Program)
PROBOR	-	Programa de Incentivo à Produção de Borracha (Incentive Program for National Rubber Production)
RIMA	-	Relatório de Impacto do Meio Ambiente (Environmental Impact Assessment)
SEPLAN	-	Secretaria do Planejamento (Planning Secretariat)
SIMI	-	Sistema de Informação de Migração Interna (Information System on Internal Migration)
SNAB/CIMAG/SDI	-	Secretaria Geral do Abastecimento (General Secretariat for Food Commodity Supply)
SOBER	-	Sociedade Brasileira de Economia e Sociologia Rural (Brazilian Rural Society of Economics and Sociology)
SUCAM	-	Superintendência de Campanhas de Saúde Pública (Superintendency for Public Health Campaigns)
SUDAM	-	Superintendência de Desenvolvimento da Amazônia (Superintendency for the Development of Amazonia)
SUDHEVEA	-	Superintendência da Borracha (National Rubber Promotion Agency)
SUFRAMA	-	Superintendência da Zona Franca de Manaus (Superintendency of the Manaus Free Trade Zone)
UDR	-	União Democrática Ruralista (Rural Democratic Union)
USAID	-	United States Agency for International Development

CHAPTER I

CHARACTERIZING THE PROBLEM

1. Amazon deforestation has captured the world's attention as have few other issues. Based largely on the exceptionally high rate of deforestation in 1987, journalists and scientists painted an alarming picture of the overall rate of deforestation and its consequences. For the world as a whole, these consequences include possible increases in global warming and the threat of loss of habitat for the world's richest stock of genetic material. For Brazil, the implications include loss of potentially productive land and river resources through erosion and sedimentation, and possible microclimatic changes resulting from alterations in the hydrological cycle.

2. To develop appropriate policies to do something about mismanagement of Amazonian resources requires more than a sense of urgency, however, it requires gaining a perspective on the actual magnitude of the problem, understanding the forces that influence individuals' behavior in the forest, and investigating the actual and potential role of government.

3. The purpose of this report is to contribute to the development of appropriate and effective environmental policies for the Amazon. Appropriate policies must be based on a correct diagnosis of the causes, nature, and magnitude of the environmental problem. Effective policies must realistically recognize the political and economic constraints facing implementation./1

4. Introduction. Rational policies are needed to guide the preservation and development of the Amazon Basin, but their formulation is complicated by the technical complexity of estimating external costs and benefits, and by the emotional nature of the issues. This report sets out the elements of the problem in as systematic a manner as possible, and develops the policy recommendations that flow from the analysis. The analysis of environmental/developmental tradeoffs in the Amazon faces two classes of problems--lack of knowledge, and differences in value judgements. This analysis cannot hope to deal with the latter, but it will attempt to narrow the scope for misunderstanding which results from lack of knowledge.

5. It is important to acknowledge at the outset, however, that most differences of opinion about appropriate policy in the Amazon rest on value judgement and uncertainty. This becomes especially important when considering the "mega" issues such as protecting biodiversity, the greenhouse effect, and

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/1 The Brazilian Government, concerned with the Amazon rain forest, but at the same time responsive to the legitimate desires of the inhabitants of the region for a higher standard of living, has indicated that they would have preferred the Bank to have moved directly to "identification of strategies for sustainable development." The view of Bank Staff, on the other hand, is that understanding the dynamics and underlying incentives of the current situation is a prerequisite to developing effective development policy for the region.

potential changes in the microclimates. In all these areas, benefits to future generations are not only unknown, but unknowable. Thus we face a choice not between known benefits of forest use to current generations and known benefits of preservation to future generations, but rather between known present benefits and largely unknowable future consequences. We are also faced with the problem of unequal distribution of benefits and costs, with the potential opportunity costs of preservation weighing most heavily on local populations and the benefits accruing globally. Given these problems, the analytic convenience of separating disagreement into facts and values is lost. Although this report will help to narrow the differences related to facts, differences in value and attitudes toward uncertainty will undoubtedly persist./2

6. This chapter describes the current state of deforestation, including its location, level, and rate, and reviews its underlying causes. Deforestation is, however, of interest only because it is an indicator of potential environmental problems; viz species loss, global warming, local watershed damage, and microclimatic change. These are also reviewed and assessed briefly.

7. Chapter II discusses the most important types of economic activity in the Amazon, and their environmental implications. Some of these activities are a direct response to government policies and public investments, but others would be carried out without them. Future government policy must therefore clearly identify the strength of the forces underlying economic development in the Amazon. This Chapter gives some sense of the relative role of such underlying forces and superimposed government policies.

8. Finally, Chapter III discusses the major economic and political factors governing the policy environment for the Amazon, and suggests an environmental strategy that addresses environmental objectives in light of the existing political and economic constraints.

A. The Policy Objectives

9. An effective policy to maximize the net social benefits from the Amazon must deal explicitly with the invisible benefits that the Amazon Basin currently provides (or the invisible costs that would be incurred under alternative land use). These benefits (discussed below in section E) are: maintaining biodiversity, controlling carbon dioxide emissions (global warming), and preserving beneficial watershed and microclimatic effects.

10. The most critical element of a policy is that it be implementable. Under the frontier conditions of the Amazon, with its poor communications, transportation, infrastructure, and most importantly, weak implementation and enforcement institutions, this is a particularly difficult requirement. Environmental legislation cannot be enforced effectively in the Amazon, for

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/2 The economics literature attempts to reduce this problem to one of differences (among individuals) over subjective probabilities concerning future outcomes. It is likely, however, that for many people the essential issue reduces to a value judgement concerning the rights of the current generation to (negatively) influence the probabilities of major environmental outcomes.

example, if the local community is openly hostile. Environmental policy must be carried out with at least the passive acceptance of the communities that live there, especially in a democratic society. Policy makers need at least a basic understanding of the incentives that drive private and public behavior in the Amazon.

11. As mentioned above, deforestation is an indicator of potential environmental problems. Any strategy to rationalize the development-preservation tradeoff must be based on the best possible understanding of (i) the current magnitude of the deforestation problem, (ii) the underlying forces leading to deforestation, and (iii) the likely environmental damage (externalities) produced by deforestation. This Chapter will address these three issues.

DEFORESTATION ESTIMATES

Estimates of Amazon deforestation change almost daily. The current most reliable and widely accepted values are based on INPE's 1989 LANDSAT-based estimates. These estimates indicate that new deforestation in 1989 was on the order of 23-26 thousand km^2, and that total deforestation by 1989 was 395,000 km^2 or 8% of the Legal Amazon. Previous estimates of annual rates of deforestation as high as 80 thousand km^2 suffered from two sources of bias. First, they were based on calculations of the burning area derived from the thermal band of the Advanced Very High Resolution Radiometer (AVHRR) on the US National Oceanographic and Atmospheric Administration meteorological satellite. Estimates based on these data suffer from severe--possibly insolvable--problems relating to adjusting for partially burning pixels and the proportion of burning to be attributed to new burning. Theoretical calculations show that a fire of only 900 m^2 is sufficient to trigger an entire pixel of 1,200,000 m^2. Second, these estimates were based on 1987, when the dry season was exceptionally long and uncertainty over the treatment of land titling and land reform in the new constitution led many settlers to attempt to reinforce their claim to as much land as possible through burning.

Box I-1

B. Deforestation Estimates

Deforestation Rates

12. Deforestation in this discussion will be defined as alteration in primary tropical forest, even if this land has been abandoned and has regrown into secondary forest. In other words, when discussing figures on total land deforested in the Amazon to date, deforestation and land alteration will be used synonymously. Estimates of deforestation in the Amazon vary considerably (Table I-1), from approximately 400,000 km^2 (INPE, 1989) to nearly 600,000 km^2 (Mahar, 1989). Although the INPE data were widely criticized when originally released in 1988, due to several presentational problems which appeared to

minimize the extent of deforestation,/3 they are in fact the only source of complete satellite data coverage (as of 1989).

Table I-1: COMPARISON OF AMAZON BURNING ESTIMATES AND LAND USE STATISTICS, NORTHERN REGION
(Thousands of square kilometers)

	Land Use Estimates (1985) /a			Annual Rate of Growth /b (1981-85)		Land Use Estimates (1988) /c				Land Alteration Estimates (1988)/d		
	Crops	Pas-ture /e	Total	Crops	Live-stock	Crops	Pas-ture	Natural Pasture	Altered Total	INPE /f	Fearn-side /g	Mahar /h
North	20.2	104.0	124			22	133	39	116	75	207	307
Acre	0.7	3.7	4	-2%	3%	1	4	1	4	7	9	20
Amapá	0.3	2.0	2	11%	0%	0	2	2	1	1	0	1
Amazonas	3.0	4.7	8	-2%	3%	3	5	2	6	18	5	106
Pará	10.5	57.6	68	3%	5%	11	67	17	61	128	148	120
Rondônia	5.4	23.0	28	7%	22%	7	42	2	46	30	42	58
Roraima	0.3	13.0	13	-1%	-1%	0.3	13	15	0.3	3	4	3
Legal Amazon	--	--	--	--	--	--	--	--	--	362	400	599

/a Source: 1985 Preliminary Agricultural Census.
/b Calculated from 1985 Preliminary Agricultural Census.
/c Calculated by applying 1981-85 growth rates to the 1985 land-use estimates. Negative growth rates were ignored since the objective of the table is to calculate the land that would have been cleared for crops. Natural pasture figures were obtained from the 1980 Agricultural Census.
/d These figures include total land altered to date, including secondary growth forest.

/e The preliminary census does not give land in pasture. Therefore land in pasture was calculated based on land in pasture in 1980 from the 1980 agricultural Census, and the increase in cattle between the two census multiplied by and average two hectares per head.
/f Based on interpretation of 1988 LANDSAT-TM imagery. Source: Fearnside, Tardin Filho, 1990.
/g Based on linear extrapolations from the two most recent (pre 1988 data) satellite measurements.
/h Based on Fearnside, 1986, and World Bank Estimates.

13. Of several estimates of Amazonian deforestation made in 1988 the INPE data appears the most accurate. As an attempt to verify this statement, available data on land use in the region (based on the 1985 preliminary agricultural census) was compared to various estimates of deforestation as of 1988 (Table I-1). The INPE data was generally found to be most consistent with changes in agricultural land uses in the North region.

/3 The original report contained two presentational shortcomings that gave the appearance that the problem of deforestation was being minimized. This was largely because the debate on the report's conclusions focused quickly on a single number--the percentage of the Amazon that had been deforested. First, over 90,000 km^2 of deforestation in Pará and Maranhão, which had taken place prior to the 1960s, and had not been picked up on earlier satellite images, was not included in the report's original total. Second, changes in vegetative cover in the Cerrado was not calculated (due to lack of time series of data). Third, the entire Legal Amazon was used as the denominator. The result is a ratio that includes "all land in the Legal Amazon" in the denominator but only "alterations in primary tropical forest since (approximately) 1960" in the numerator. Critics would have preferred either "all alteration in vegetative cover" in the numerator, or "original primary forest area" in the denominator.

Table I-2: COVERAGE OF GEOGRAPHICAL TERMS IN THE AMAZON BASIN

Name of Area	Area Coverage	Comments	
Amazon River Drainage Basin	Approximately 6,600,000 km^2	Includes land in Brazil, Colombia, Ecuador, Peru, Bolivia, and Venezuela.	
Brazil's Legal Amazônia	Approximately 5,000,000 km^2	Brazil's North Region (consists of the states of Acre, Amapá, Amazonas, Pará, Rondônia, and Roraima), and Mato Grosso, Tocantins, and Maranhão west of the 44th Meridian.	Legal definition purposes of regional planning and policy. Comprises about 60% of the nation's land and 10% of its population. Brazil's legal Amazônia contains approximately 3,000,000 km^2 upland dense forest, 1,200,000 km^2 scrub forest, and 250,000 km^2 of other upland forest types. The reminder is a mix of humid savanna, flooded forests, and montene forests. (Fearnside, 1987.)
Brazil's Classic Amazônia	Approximately 3,500,000 km^2	Brazil's Northern Region.	Represents Brazil humid lowland portion of the Amazon River Basin. This text refer to this area as "the North."
North plus Mato Grosso	Approximately 4,400,000 km^2	Northeastern Region (six states listed above) plus Mato Grosso.	Closest approximate to the Legal Amazon for which data are generally available.

14. Discrepancies (Table I-1) between the deforestation that would be expected based on the estimated land-use data and that of INPE satellite image interpretations are largely explained by two factors: 1) The INPE figures include land that was previously in agricultural use, but that has since been abandoned and has regrown into secondary forest. This explains essentially the entire discrepancy in the North[/4] and 60 percent (about 40,000 km^2) of the discrepancy in Pará. 2) The 1988 land use data is extrapolated from the 1985 data using the average annual growth rates between 1981 and 1985. Although this methodology is best available, actual rates of growth due to migration have not remained constant as assumed. For example, in Rondônia the projections of land use in Table I-1, assumed that the rate of growth of crops and livestock would remain the same over 1986-88 as over the previous five years, creating a projected increase over 1985-88 of 21,000 km^2. The rate of migration has however fallen sharply since 1985, so the overall population growth rate probably fell from 12% over 1981-1985 to approximately 7% since 1985. In addition, land is being consolidated and transformed into pasture in Rondônia. New pasture, therefore, tends to be established on abandoned crop land, not created through new clearing.

/4 The North here includes the state of Maranhão, Mato Grosso and Tocantins. In Maranhão, approximately 58,000 km^2 that had been deforested prior to 1960, had since grown into secondary forest, and was not distinguishable from primary forest on pre-1988 satellite imagery.

Problems of Trend Analysis

15. The sense of urgency concerning deforestation in the Amazon largely results from projections of future deforestation that have been made on the basis of past experience. On this basis, for example, Fearnside suggested in 1982 that the states of Pará, Maranhão, Goiás, Rondônia, and Mato Grosso could be completely deforested by 1990. Current satellite imagery (INPE 1990) shows that even in Rondônia, the most deforested of the Amazonian states, only 13% of the land area has been deforested.

16. Why has trend analysis done so poorly? Principally, because it fails to take into account the underlying causes of the behavior being observed, and factors which might constrain it. This problem is seriously exacerbated when it is assumed that the behavior will grow at an exponential rate./5 Such an approach is badly flawed.

17. First, any projection on the basis of trend analysis must assume that the underlying forces that cause the trend will remain largely unchanged during the projection period./6 For example, the rapid deforestation in Rondônia during the second half of the 1970s was due largely to the construction and later the paving of BR-364, and the network of (generally poor quality) feeder roads that were later constructed (Mahar, 1989). Without the market access provided by these roads, there would be little incentive to clear forest. Thus, as land near BR-364 became deforested, the incentive to clear more remote land (and face ever-increasing transportation difficulties) should decrease, and therefore so should the pace of deforestation.

18. Fitting an exponential function to the deforestation data implies the adoption of opposite assumptions, however. In effect, it assumes that the percentage increase in land deforested is constant every year--so that the amounts deforested each succeeding year constantly increases. In order to justify such a projection one would have to explain how new farmers, burning land farther and farther away from roads, would get their crops to markets. That, in turn, would require an explanation of why the government would initiate (and how it would fund) an exponential increase in road building.

19. Figure 1 demonstrates the dangers of such exponential projections. The straight line at the top represents the amount of land in the state. The next four lower curves are exponential projections of forest clearing in Rondônia. The lowest curve traces the actual observed data from satellite imagery. Starting with the top, each exponential projection was made with the data available at the time. Thus, the top curve represents an exponential curve

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/5 In fairness, Fearnside was only showing the power of exponential growth. He then went on to discuss factors that might alter this growth rate. Others have not been so careful.

/6 A distinction should be made between "modeling" a phenomenon and projecting on the basis of trends. A "model" should incorporate the significant factors influencing the behavior explored. Trend projections tend to ignore them.

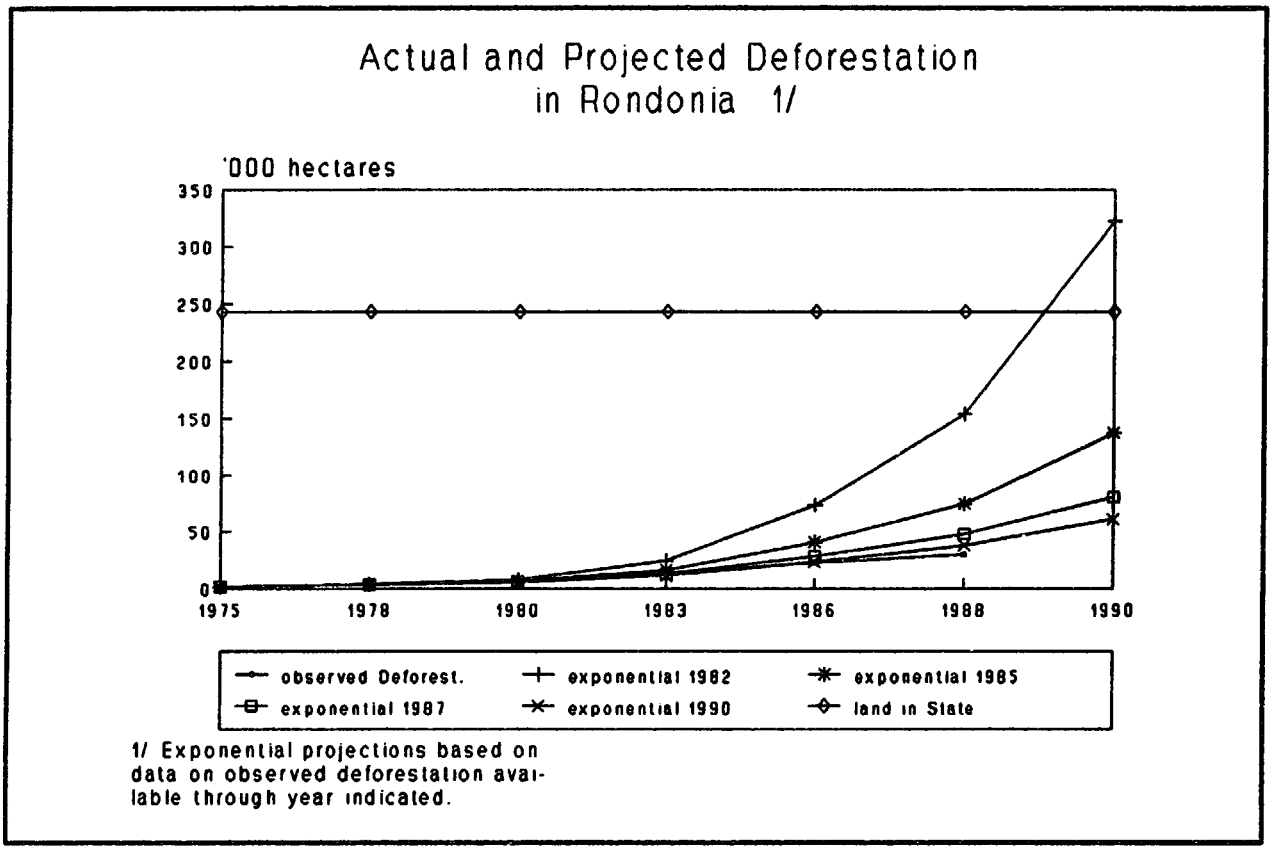

Figure I-1

fitted to the data available through 1982 and trended to 1990. This curve does, indeed, exceed the 243,000 km^2 of Rondônia's total area prior to 1990. As subsequent imagery became available, however, exponential growth assumptions are increasingly untenable. As Figure 1 shows, each subsequent data point lowers and flattens the curve.

20. The assumption of exponential growth is, therefore, clearly inappropriate on a priori grounds. This position is empirically reinforced by comparing (Figure 2) a linear projection based on data available through 1982 with the exponential projection made in both 1982 and 1987. A linear projection in 1982 would have predicted 1988 deforestation better than an exponential projection in 1987.

21. Figure 3 contrasts INPE's actual observed deforestation for the entire Legal Amazon through 1988 with several earlier estimates. As with the case of Rondônia, a straight line extended from the data of 1975 and 1978 would have provided a better estimate for 1988 deforestation than did the alternatives./7

/7 The difference between the two 1988 INPE observations is explained by the 40,000 km^2 and 58,000 km^2 deforested prior to 1960, in Pará and Maranhão, respectively, which has since grown into secondary forest, and was not visible on pre-1988 satellite imagery.

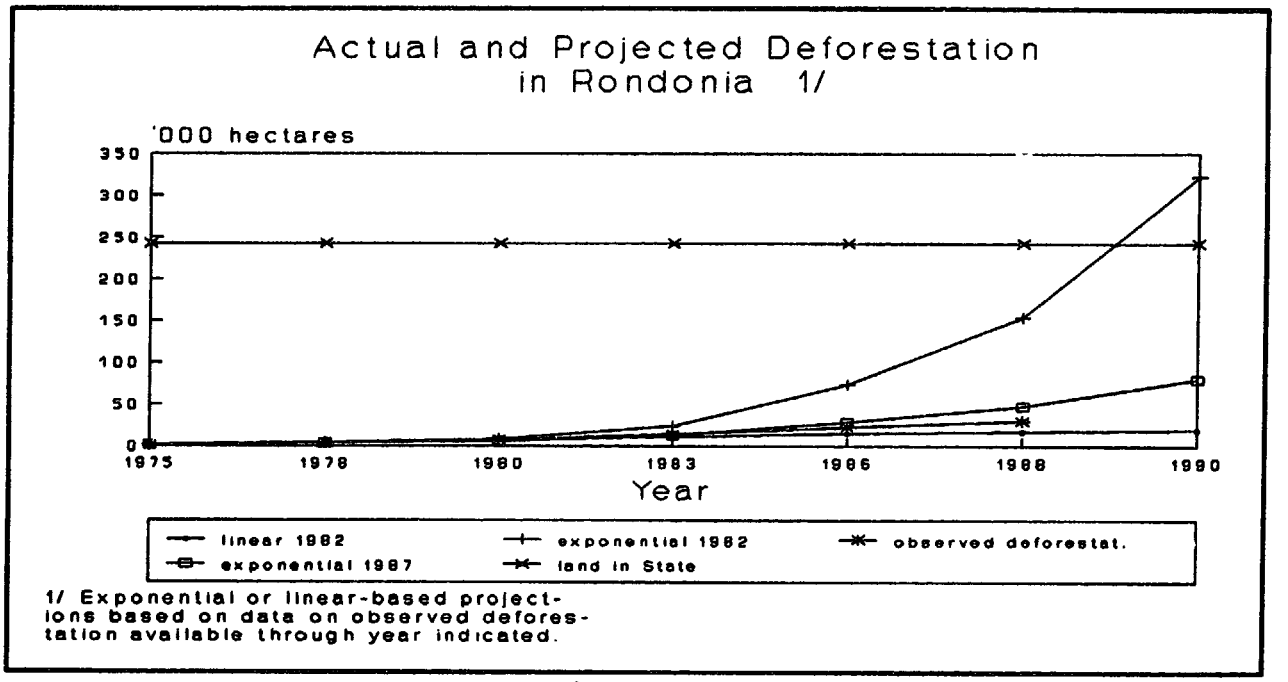

Figure I-2

C. Indicators of Changes in Deforestation Pressure

Agriculture

22. The major factor determining future pressure for deforestation is the growth of agriculture, mostly in Rondônia, Acre, and Pará. Demand for wood for fuel and carbon (in pig iron production) is also an important factor in the western Amazon (Pará and Maranhão). Increasingly, evidence indicates that agriculture in the Amazon is growing more slowly, or even contracting. As shown in Table I-3, virtually all indicators of agricultural growth in the North fell sharply in the 1980s. For Acre, Amazonas, and Roraima, the land under cultivation decreased in absolute terms between the 1980 and the 1985 census, as did the number of cattle in Roraima. Except in Rondônia and Amapá, the number of tractors also decreased.

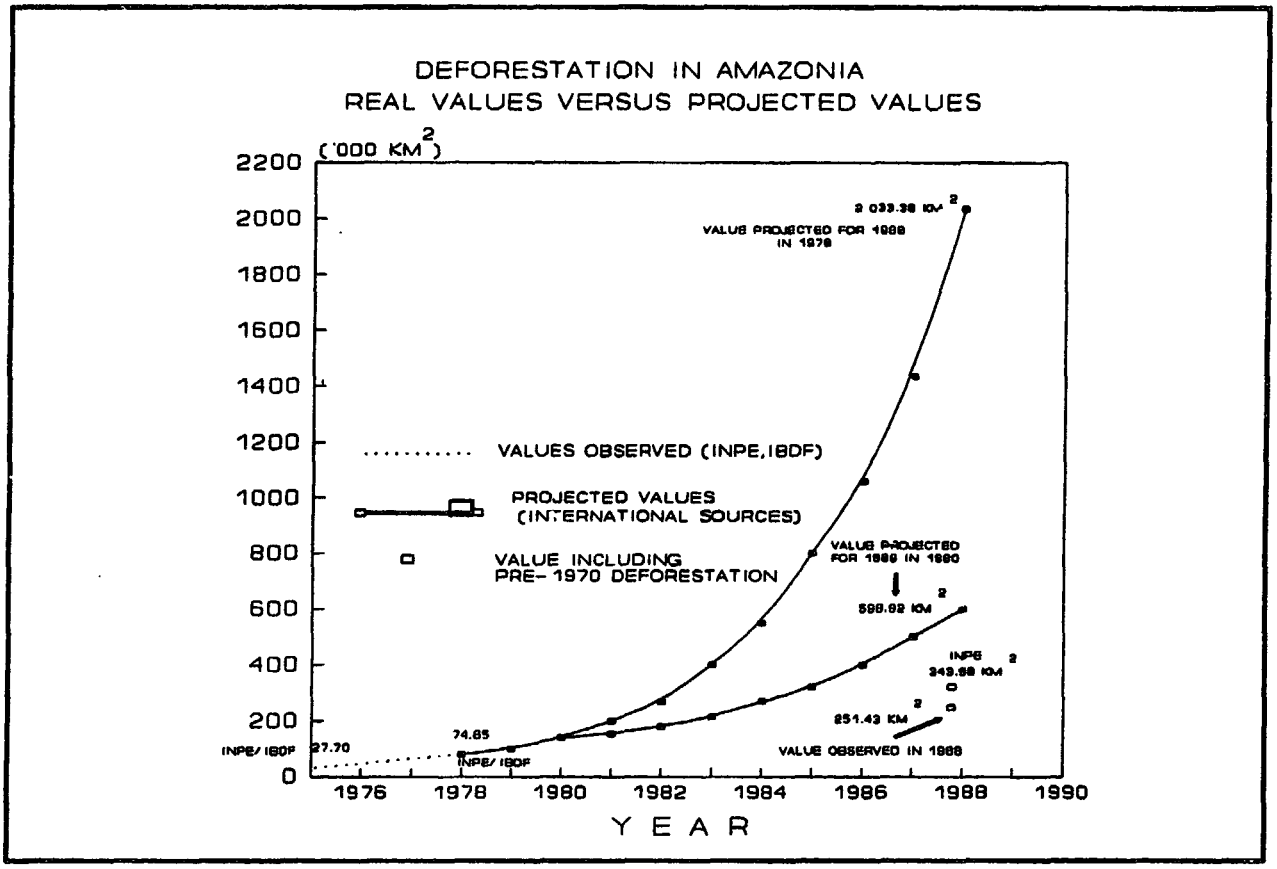

Figure I-3

Migration

23. Migration data, although available on a consistent basis only for Rondônia,/8 tell a similar story. The data on migrants counted at the Vilhena checkpoint presented in Table I-4 show a sharp drop after 1986.

24. There is also evidence that colonization projects began to suffer from low occupancy levels during the 1980s. In 1987, CEDEPLAR found families living on only 50% of the lots in the Machadinho settlement project tracts distributed in 1984--a project with unusually complete infrastructure. The nearby Cujubim

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/8 Data from SIMI (Information System on Internal Migration) stations in the eastern Amazon are not very meaningful because they are not situated in "gateway" cities like Vilhena, through which practically all migrants must be funnelled. The main entry points in the eastern Amazon are Marabá (CEDEPLAR 1977) and Conceição do Araguaia (CEBRAP 1978, Chase 1985). There is also movement directly into rural areas along roads such as the Pará-Maranhão road (BR-316), the "Mato Grosso road" (BR-158), and the Cuiabá-Santarém road (BR-163). Furthermore, cities in neighboring states such as Imperatriz in Maranhão (Bitoun 1980) and Araguaína in Goiás (Hebette and Azevedo 1980) also serve as nodal points for migrants.

Table I-3: INDICATORS OF AGRICULTURAL TRENDS IN THE NORTH AVERAGE ANNUAL RATES OF GROWTH (In Percent)

	1950-60	1960-70	1970-75	1975-80	1980-85
Area in Crops					
North	5	4	13	8	3
Rondônia	10	13	29	13	7
Acre	4	6	3	12	-2
Amazonas	6	5	6	10	-2
Roraima	11	9	33	2	-1
Pará	6	2	13	5	3
Amapá	26	2	18	-5	11
Persons Employed					
North	5	6	7	8	1
Rondônia	-1	16	32	11	12
Acre	6	7	4	4	4
Amazonas	7	5	8	12	-7
Roraima	3	9	17	-2	5
Pará	4	6	5	5	3
Amapá	5	8	12	-5	8
Tractors					
North	20	10	9	26	-1
Rondônia	7	16	5	43	11
Acre	14	2	13	34	-4
Amazonas	10	10	7	31	-1
Roraima	-7	16	35	30	0
Pará	24	10	9	24	-3
Amapá	14	4	5	9	3
Cattle					
North	2	3	4	13	6
Rondônia	5	19	17	30	22
Acre	3	8	10	18	3
Amazonas	5	6	-5	11	3
Roraima	2	4	1	5	-1
Pará	1	2	6	13	5
Amapá	4	4	-1	-6	0

Source: 1985 Preliminary Agricultural Census.

project, also undertaken with World Bank support as part of the POLONOROESTE initiative, had even fewer inhabitants. There are reports that 70% of the lots in the Carajás colonization project in Pará were abandoned.

Table I-4: MIGRATION TO RONDÔNIA, 1979-89

Year	Number
1977 (a)	6,280 (d)
1978 (a)	12,658
1979 (a)	36,791
1980 (a)	49,205
1981 (b)	60,218
1982 (b)	58,052
1983 (b)	92,723
1984 (b)	153,327
1985 (b)	151,621 (e)
1986 (b)	165,899
1987 (c)	103,654
1988 (a)	51,950 (f)

Sources: 1977-83 - NURE-MIGR-RO (1984:Tabela 01), 1984/85 - **Boletim de Migração**, v.5. n.13, p.9., 1986/87 -**Boletim de Migração**, v.7, n.20,. p.7.

Notes: (a) Data for CETREMI in Vilhena only; (b) Data for CETREMIs in Vilhena and other cities; (c) Data for CETREMI in Vilhena only starting in May; (d) Data for second semester multiplied by 2; (e) Vilhena post was closed at night for part of the year; and (f) Possible problems of coverage in second semester, due to financial difficulties of program. However, second semester total (25,528) was

D. The Determinants of Future Pressure

25. Future pressure for deforestation in the Amazon will reflect both the underlying dynamics of population and economic pressures, and future government investments and policy choices.

Demographic Forces

26. Land consolidation and labor-saving technology, partly encouraged by policies and partly due to the intrinsic nature of new crop technology,[9] resulted in some 16 million rural Brazilians migrating to cities between 1970 and 1980.[10] During this same period, net migration to the North was approximately 770,000 (Wood and Wilson, 1984). Obviously, urbanization was a much more powerful magnet than migration to the Amazon.

27. Changes in the pool of potential migrants will continue to reduce migratory pressure. In the past, migrants for rural settlement tended to come from rural areas, and with little or no urban experience. They were also young, generally between the ages of 20 and 40 (Annex I).

Table I-5: RURAL MALE POPULATION AGE 20-39, BRAZIL, 1950 TO 1980

Year	Non-Amazon rural males age 20-39 /a	Total population of Brazil
1950	4,653,080	51,941,767
1960	5,168,692	70,070,457
1970	5,299,237	93,139,037
1980	5,308,915	119,002,706

Source: Total population by age and sex from Paiva, Carvalho and Leite (1987:33). Rural-urban distribution from Sinopse Preliminar do Censo Demográfico, 1980.

/a Assuming the same proportion of males 20-39 in the rural population as in the total population and the same proportion for rural males age 20-39 as for all males.

28. As illustrated in Table I-5, this pool of potential future migrants essentially stopped growing in the 1970s. This was due to rapid urbanization, as 67% of the population lived in urban areas by 1980,[11] and to fertility decline, which began in the mid-1960s and affected both rural and urban populations. By 1990, fertility decline and urbanization will probably have caused an absolute decline in the stock of potential migrants.

Land Prices

29. The increase in southern land prices relative to those in the north have been a powerful force driving migrants to the north. They make farming increasingly inaccessible to the landless, and also displace less intensive land uses such as ranching, tending to drive them to cheaper land elsewhere. A steep

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/9 The machinery used in cultivating wheat and soybeans was developed in the US for the American west and midwest, where the man/land ratio was very different than in Brazil's relatively heavily populated rural south. There was probably, therefore, also a technological labor saving bias in addition to the bias imposed by subsidized credit.

/10 Martine (1988) estimates that 13 million people left rural areas over the decade 1960-70.

/11 This is based on the Brazilian Census definitions of urban, which is based on administrative criteria--basically classification as district or municipal areas (see Annex 7).

land price gradient, with high land prices in the south and low prices in the north, has encouraged small- and medium-sized farmers in the south to become large farmers in the north. It also encouraged cattle ranching in the north.

30. Table I-6 shows the dramatic changes in real land prices in Brazil over the past two decades, both absolutely and in terms of the north-south price gradient. These prices result from several factors, some but not all directly under government influence. In general, the increased prices reflect the increased scarcity and increased productivity of land. However, government subsidies and preferential tax treatment probably increased land prices in the south faster than land productivity justified.

Table I-6: REAL PRICE OF LAND IN BRAZIL'S FIVE REGIONS
NORTH, 1970 = 100

Year	North	Northeast	Center-West	Southeast	South
1970	100	70	92	205	165
1971	96	64	93	229	183
1972	72	67	124	305	222
1973	55	77	211	567	401
1974	64	107	295	681	633
1975	78	174	314	1,014	679
1976	71	154	295	818	735
1977	107	172	260	832	796
1978	96	165	252	798	692
1979	84	171	294	797	679
1980	55	129	369	574	586
1981	86	220	389	828	833
1982	56	221	337	743	837
1983	84	121	270	564	766
1984	94	148	407	689	859
1985	126	183	459	833	1,021
1986	201	371	848	1,680	1,409
1987	135	287	476	1,009	941

Source: FGV, Preços Médios de: Arrendamentos, Venda de Terrenos, Salários, Empreitados, Transportes. Deflated by the IGP-DI.

31. Agricultural productivity, stirred by substantial advances in agricultural research (especially for wheat and soybeans in the South, Southeast, and, later, Center-West) led to dramatic increases in land productivity, which were quickly reflected in higher land prices. Government policy encouraged large land holdings through subsidized credit and preferential agriculture. Together, these factors raised land prices more in the south than elsewhere, where agricultural land was more productive./12 Macroeconomic factors are also important, as can be seen from the (temporary) near doubling in land prices associated with the flight to real assets during the Bresser Plan (1986).

32. The importance of the extraordinary skewing of the land-price gradient that took place in the early 1970s can be seen from Table I-7. A small farmer in the south contemplating selling out to his large neighbor in 1970 could only double the size of his farm by moving north. Five years later, however he

/12 The increase in the land price gradient results from the fact that the equilibrium on post-tax rates of return between agricultural incomes and other incomes is achieved when the pre-tax rate of return on capital invested in agriculture is on the order of 65% of the average pre-tax rate of return in other sectors. When pre-tax agricultural incomes exceed this amount, the tendency is for the difference to become capitalized into the price of land. This condition is more likely to hold for the more agronomically productive (and closer to market) land in the south than in the north.

could expand his farm size tenfold. Apparently, for a short period during the early 1980s, he could obtain fifteen hectares in the North for every hectare sold in the South.

Table I-7: HECTARES OF LAND IN NORTH THAT COULD BE PURCHASED BY SELLING A HECTARE IN OTHER REGIONS

Year	North	North-east	Center-West	South-east	South
1970	1	0.7	0.9	2.0	1.6
1971	1	0.7	1.0	2.4	1.9
1972	1	0.9	1.7	4.2	3.1
1973	1	1.4	3.8	10.3	7.3
1974	1	1.7	4.6	10.6	9.8
1975	1	2.2	4.0	12.9	8.7
1976	1	2.2	4.2	11.5	10.4
1977	1	1.6	2.4	7.7	7.4
1978	1	1.7	2.6	8.3	7.2
1979	1	2.0	3.5	9.5	8.1
1980	1	2.3	6.7	10.4	10.6
1981	1	2.6	4.5	9.6	9.7
1982	1	3.9	6.0	13.2	14.9
1983	1	1.4	3.2	6.7	9.1
1984	1	1.6	4.3	7.4	9.2
1985	1	1.5	3.6	6.6	8.1
1986	1	1.8	4.2	8.4	7.0
1987	1	2.1	3.5	7.4	6.9

Source: FGV, Preços Médios de: Arrendamentos, Venda de Terrenos, Salários, Empreitados, Transportes. Deflated by the IGP-DI.

33. The influence of relative north-south land prices on migration has decreased in recent years; in 1987, the price of land in the south was less then 7 times that of land in the north. The change is due largely to the real increase in the price of land in the north which began in the later 1980s. It resulted from the ending of the federal building of new roads in the Amazon, and the paving of existing roads, especially BR-364.

34. The lack of new roads created a scarcity of accessible, productive land./13 As long as access to new lands was assured (or expected) by continued road building, land at the frontier (along existing roads) developed little scarcity value. This is particularly evident in Table I-6; despite the fourfold increase in the value of land in the center-west (Mato Grosso, Mato Grosso do Sul, Goiás, Federal District) between 1970 and 1984, land values in the North (Rondônia, Acre, Amazonas, Roraima, Pará, Amapá) showed no upward trend, while more government road construction was expected. New road building began to decline dramatically in the early 1980s, however (Figure 4), and price pressure began to emerge even in the North. This pressure undoubtedly increased when road improvement programs, such as the paving of BR-364 into Rondônia, reduced transportation costs to areas already accessible, but did not open up new land.

35. In the long run, if new land is not opened through new roadbuilding, land prices will tend to vary along a gradient that reflects relative (after tax) profits as a function of distance from market, agronomic potential, and the availability of services. As this equilibrium is neared, there is little pressure for new migration (as potential migrants cannot improve their lives by moving. As discussed above, however, this equilibrium is sensitive to any government investments that provide access to new lands and to any government policies that reduce the cost of doing business in one place relative to another.

/13 There is no scarcity of unproductive land, or land with poor access, however, as noted above in the discussion of low occupancy rates on existing settlement programs.

36. Agriculture in the Amazon depends heavily on the availability of local markets, given the long distances and high costs of transporting agricultural goods to the populated states in the south. Those products and those areas do well which can benefit from the natural protection these high transport costs afford against competition from the south. In general, those products that must exported to the south have survived only if subsidized.

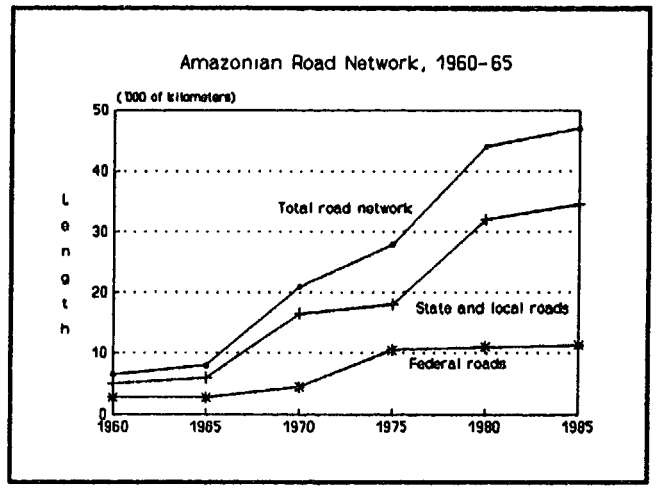

Figure I-4

Urbanization and the Growth of Local Markets

37. The rapid growth of urban markets in the north has been critical to the economic viability of Amazonian agriculture. As shown in Table I-8, the ratio of urban dwellers to rural residents in the North increased from less than a half in 1950 to over 1.2 in 1990. In the 1950s and 1960s, the urban population grew at twice the rate of the rural population. This signals a clear turning of the rural-urban terms of trade in favor of the farmer, undoubtedly contributing (along with the factors discussed above) to the increased profitability of Northern agriculture./14

38. Several factors will determine the future growth of cities in the Amazon. As shown in Table I-9, agriculture in the North in 1980 (the most recent date for which regional income data are available) represented 16% of regional value added (or 0.48% of Brazil's national income). Urban-based activities, on the other hand--industry and mining and services (including government)--represented the remaining 84%. The urban-based service sector dominates the Amazonian economy. The sector includes government, commerce, financial, and other services required to sustain the basic activities of agriculture, agro-processing, timber, and mining. For the North as a whole the service sector represented 47% of value added in 1980, compared to 52% for Brazil as a whole, with the government's share reaching a high of 22% of value added for Roraima, 17% for Amapá, 16% for Acre, and 11% for Rondônia (Table I-9). For these new states, this government share is carried largely by federal transfers, which represent an injection of demand into the local economy rather than a drain on local directly productive resources. Table I-10 shows the North's heavy dependency on federal transfers. Amazonas, which has benefitted from the free-zone status of Manaus, is the only Amazonian state with a dominant industrial sector, with over 50% of its value added coming from industry.

/14 Note that there has been change in agricultural technology in the Amazon over the period. Under these circumstances the increase in the ratio between the number of rural and urban residents can be taken as a rough proxy for the increase in the demand for food relative to its supply.

Mining

39. Mining puts pressure on the forest both through its impact on local demand for agricultural goods and its direct environmental consequences. Mining, however, is the growth industry of the Amazon. The mineral wealth of the Brazilian Amazon has been estimated at $3 trillion, with deposits of gold, bauxite, iron ore, tin, copper, uranium, potassium, rare earths, niobium, sulfur, manganese, schist, diamonds, and other precious stones. New mineral deposits are discovered every year. Last year, for example, new tin ore and gold deposits were discovered in Rondônia. Other sites remain to be fully explored, such as the giant Salobo copper reserve (in the Carajás range of Pará) with an estimated 1.2 billion tons of copper ore. In Pará, 36% of the state (449, 263 km^2) is officially under either mining or prospecting concessions.

Table I-8: POPULATION TRENDS IN THE NORTH
(In Millions)

	1950	1960	1970	1980	1990
Total /a	1.8	2.6	3.6	5.9	9.1
AARG /b	..	3%	3%	5%	4%
Urban /c	0.6	1.0	1.6	3.0	5.0
AARG /b	..	5%	5%	6%	5%
Rural	1.3	1.6	2.0	2.8	4.1
AARG /b	..	2%	2%	4%	4%
Memorandum item:					
% urban	31.5	37.8	45.1	51.7	55.0

Source: 1980 Preliminary Demographic Census. For 1990 population estimate of Hakkert (1990), urbanization rate is staff estimate.

/a Total may not add due to rounding.
/b Annual average rate of growth over previous decade.
/c Population in district or municipal seat (Census definition).

Table I-9: NATIONAL INCOME ACCOUNTS - NORTHERN STATES
COMPOSITION OF VALUE ADDED, 1980

	Total	Agri-culture	Industry & Mines	Total Services	Transport & Commerce	Financial Commun.	Public Instit.	Admin.	Rental	Other Services
North	100	16	37	47	16	4	3	8	7	9
Rondônia	100	21	27	53	14	6	2	11	10	10
Acre	100	25	23	53	15	3	3	16	6	11
Amazonas	100	9	51	41	14	3	4	8	5	8
Roraima	100	18	16	66	19	4	3	22	7	11
Pará	100	20	31	49	17	4	3	7	8	10
Amapá	100	15	31	54	12	5	1	17	10	9
South	100	17	36	47	15	5	6	5	6	10
Memoranda Items: percent of national value added:										
Brazil	100	100	100	100	100	100	100	100	100	100
North	3	5	3	3	3	3	1	4	3	2
South	17	29	16	15	18	19	16	14	14	14
Paraná	6	11	5	5	7	7	4	4	4	5
Sao Paulo	37	14	47	35	36	39	35	24	36	37

Source: FGV.

Public Spending and Policies

40. As will be discussed in greater detail in the final chapter, changes in several government policies have reduced deforestation pressures. New federal

road building in the Amazon has stopped, although local and state governments are still building roads. The minimum price program--which artificially supported prices for food crops in the north--has been regionalized under the Collor government, and that should result in prices that are closer to market levels in the north. The regional incentives scheme which subsidized large-scale cattle ranching has been terminated, and both the (subsidy) rate and the volume of subsidized credit have been reduced dramatically. The preferential tax treatment of agricultural incomes has also, in principle, been terminated, although there is still a loophole of unknown significance. Finally, legislation which encouraged homesteaders to deforest in order to improve the legitimacy of their claims to land titles has now been reversed.

Table 1-10: BRAZIL: NET IMPACT OF FEDERAL GOVERNMENT ON STATES
(1988 NCz$ Per Capita)

Federated Unit	Budgetary Revenues	Federal Government Expenditures	Tax Transfers to States	Tax Transfers to Munic.	Net Impact of Federal Government
Acre	6.63	58.94	48.90	9.91	111.12
Amazonas	30.85	23.74	11.94	5.72	10.56
Pará	14.14	14.18	9.04	5.07	14.15
Amapá	15.90	91.00	77.66	12.11	164.88
Rondônia	8.64	71.90	17.88	6.31	87.45
Roraima	22.53	169.95	122.56	21.16	291.16
North	17.05	29.77	16.15	6.01	34.88
Center West	10.93	14.21	6.53	6.84	16.65
Northeast	13.33	19.20	7.99	6.02	19.89
Southeast	94.90	59.66	2.58	3.77	-28.89
South	37.46	22.26	3.18	5.53	-6.49

Source: Budgetary Revenues and Fed Gov Expenditures: BGU II 34; Tax Transfers to States: SEF/MINIFAZ (States, Banco do Brasil and INCRA); QUADRO III - TRANSFERENCIAS DE TRIBUTOS - 1988; Tax Transfers to Munic: same as for states; Net Impact of Federal Government = Federal Expenditures + Tax transfers - Budgetary Revenues.

Note: Center West region data excludes the Federal District.

41. It is too early to judge the effectiveness of these policy changes and it will, in any case, be difficult to sort their effect from that of the other economic and demographic factors discussed above. Both the reduction in agricultural credit and the regional differentiation of minimum (support) prices will reduce the private profitability of agriculture in the North, and should, therefore, reduce deforestation pressure. The importance of changes in the treatment of land tenure provisions will depend on whether or not squatters and settlers continue to believe that having cleared land will be considered a factor in their favor in the local adjudication of land disputes. Local practice in the Amazon may not always correspond well with Federal policy.

E. Environmental Issues

42. At the global and international level, the major concerns associated with Amazonian deforestation are (i) loss of potentially valuable genetic material and information through the extinction of unique plant and animal species; and (ii) effects on the global climate through the release of greenhouse gasses, and effect on the microclimate of the Amazon basin and proximate territories through alterations in local hydrological cycling. However,

potential global environmental costs are difficult to estimate given both the high degree of uncertainty over the long-run physical consequences of current activity, and their likely economic consequences.

43. At the local and regional level, other types of environmental damages are present, and here it is much easier to estimate the environmental damage from deforestation. These issues include especially watershed-level problems such as costs imposed on downstream populations by increased upstream erosion caused by deforestation.

F. Global or International Externalities

Species Diversity[15]

44. The Amazon Basin is widely recognized to contain the richest reservoir of genetic material in the world. The rain forest itself, for example, supports 30,000 species of plant life, compared to an estimated 10,000 plant species in all of temperate South America, and 3,300 native plant species found in all of Canada (Mahar, 1989). Similarly, the Amazon River contains over 2,000 known species of fish, over eight times the number in the Mississippi River Basin, and ten times the number found in all of Europe. The value of the genetic information stored in this abundance of life is incalculable, but according to the World Resources Institute, fewer than 1% of tropical plants have been screened for potentially useful properties.

45. The useful properties of plants or animals can be exploited in three basic ways. First, the plant or animal itself can be harvested, either for direct consumption or as an input into the production of something else (e.g., rubber, palm hearts, brazil nuts). Second, the plant or animal may contain genetic material which can be bred into a distant member of the same species to improve its economic usefulness. This is especially important with respect to rice, millet, corn and wheat, where the economically superior performance of commercial varieties has narrowed the natural diversity tremendously, greatly increasing the vulnerability of these crops to evolving pests.[16] Because native varieties of these crops are not found in the Amazon, however, the issue of genetic erosion in these crops is not of much direct relevance to Amazonian deforestation. Finally, plants and animals may possess properties which are economically useful and which can be replicated or synthesized. Here, species diversity essentially provides information. However, it is the information that is important, not the genetic material itself.

46. This final potential benefit from preserving Amazonian species is clearly the most important, and is probably becoming more so as biotechnology permits molecular biologists to engineer (transgenic) organisms not just from closely related species, but from distantly related species or even organisms from different kingdoms. Increasingly, the value of natural organisms will come

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[15] This discussion is limited to potential economic and technical costs associated with species loss, and does not involve wider ecological, ethical, or aesthetic issues.

[16] Technological advances in chemical and biological control of pests has mitigated this vulnerability substantially.

to reside not so much in their value as raw material for production, but much more in their value as models for the development of new processes and products.

47. It is extremely difficult to judge the value of the potential information loss due to species reduction caused by deforestation of the Amazon. Any effort to do so, however, must take into account both the relation between land area and species viability, and the potential for studying species now, rather than preserving them for future studies. Nonetheless, island biogeography--the branch of biology concerned with the relationship between species and land area--has found that typically the number of species within clusters of islands increases approximately as the fourth root of the area of the island (MacArthur and Wilson, 1967; Wilson, 1988). This implies that with a reduction in area of 90%, the number of species is roughly halved.

48. Assuming for simplicity that the Amazon would be deforested at a linear rate in 100 years (the current rate appears substantially below this), then 90% of the forest and 50% of the species would be gone in 90 years. By then, if no efforts were made to extract the information embodied in these plants and animals, 50% of the potential value of such information would be lost./17

49. Assume now that instead of letting species become extinct with no effort to extract this potentially useful knowledge (call it "genetic information" for convenience), a systematic program of research is put in place. This would reduce the information loss, but since today's science cannot learn as much from living species as would future science, there remains the information loss due to scientific progress--essentially the difference between what we can learn today from living organisms, and what could be learned in some future time with "perfect" knowledge. For the sake of illustration, Table I-11 calculates the information loss that would be incurred assuming a linear increase in knowledge from a current level where 50% of the potential information is lost to a level 100 years

Table I-11: GENETIC INFORMATION LOSS DUE TO DEFORESTATION HYPOTHETICAL EXAMPLE

Exponent /a	0.25
Deforestation time	100 years
Knowledge Growth	100 years

Year	Area remaining	Species remaining	Species studied	Information loss from studying	Total species information lost
1990	100,000	996	0	50%	0.00%
2000	90,000	970	26	48%	1.27%
2210	80,000	942	28	43%	1.23%
2220	70,000	911	31	38%	1.20%
2230	60,000	876	34	33%	1.15%
2240	50,000	837	39	28%	1.11%
2250	40,000	792	45	23%	1.05%
2260	30,000	737	55	18%	0.99%
2270	20,000	666	71	13%	0.92%
2280	10,000	560	106	8%	0.82%
Totals	10,000	560	436	--	9.74%

/a Number of species =K(land area)$^{.25}$.

/17 This analysis (and that which follows) assumes that the Amazon is one giant island (which) presumably would contain many smaller sub-islands. The size of an island over which the observed empirical relationship between species number and land area continues to apply is not clear, however.

from now where no information is lost from studying rather than preserving. These assumptions would yield a loss of 10% of the total information, assuming a constant rate of deforestation over 90 years and that 10% of the forest is preserved thereafter.

50. The sensitivity of the information loss to the assumptions concerning the present state of science (current information loss from studying now relative to preservation) and the relationship between land area and species number (the exponent)[18] is shown in Table I-12. This suggests that the information loss from deforesting 90% of the forest over a 90-year period could be as low as 6% if the exponent is at the low end of the empirically observed range (MacArthur and Wilson, 1967) and current information loss is as low as 50%. It would be 25% if the exponent is at the high end of the range and current information loss turns out to be as high as 95%. Clearly, these results, which are illustrative only, would be sensitive to the intensity of the research effort, as well as the rate of technological change.

51. From an utilitarian perspective, the problem of species diversity is best understood as a problem of information. Policies to optimize social welfare, therefore, should aim for an optimal mix between protecting species and habitat and increasing research on species in danger of extinction. It should also be noted that the above hypothetical exercise deals only with loss of information which may yield socio-economic benefits, and not the myriad other values associated with species and habitats.

Table I-12: INFORMATION LOSS OVER 90 YEARS RESULTING FROM DEFORESTING 90% OF THE FOREST AND STUDYING LIVING SPECIES

Exponent	Assumed Initial Information Loss From Studying /a		
	50%	75%	95%
0.15	6%	9%	12%
0.25	10%	15%	19%
0.35	13%	19%	25%

/a Assumes constant reduction in information loss to 0 in 100 years.

Greenhouse Effect

52. The so-called greenhouse effect results from the capacity of certain long-lived industrial and agriculturally-generated atmospheric gases to trap some of the sun's heat, preventing it from being radiated back out of the earth's atmosphere. While there is no dispute in the scientific community over the greenhouse property of these gases, there is substantial disagreement over the climatic implications. Although globally averaged air temperature data, based on temperature data from thousands of reporting stations throughout the world, indicate that six of the warmest years on record occurred during the 1980s, recently reported results from ten years of temperature measurements (1979-88) by the TIROS-N weather satellite found no trend over the period (Spencer and Christy, 1990). According to the investigators, regional temperature swings were quite dramatic, but the thermal changes tended to even out on a global basis. Over the decade, the temperature in the northern hemisphere went up slightly while that in the southern hemisphere fell, resulting in a net global effect of zero. The scientists claim that

/18 The percent of information loss from a given percent loss in land area is independent of initial land area or number of species.

detecting a climatic trend from space--which avoids biases associated with land based thermometers--will take at least another decade of satellite measurements.

53. Clearly, then, current concern about global warming does not stem from direct observation of climate changes. It results, rather, from the known greenhouse properties of the greenhouse gases, which in the absence of policy changes will double relative to pre-industrial revolution levels over the next 80 years, and from climatologists' predictions of the effect of this doubling. To predict climatic changes resulting from greenhouse gas buildup, scientists use climate models that are mathematical representations of such variables as temperature, humidity, winds, soil moisture, and sea ice. The predicted equilibrium temperature change is the temperature that would be reached when all of these other variables would have adjusted to the change induced by increased levels of greenhouse gases. Nordhaus (1990) reviewed the results of these "general circulation models" (GCMs) and summarized as follows: (i) the central estimates of the equilibrium impact of CO_2-increases have changed little since the earliest calculations; (ii) model estimates are not converging; and (iii) while modelers have concentrated on the eventual equilibrium temperature, the rate of increase of temperature, which is more important from the standpoint of social cost, has not been established. These points are elaborated below.

54. The last thorough review by the National Academy of Sciences concluded in 1983 that global models indicate an equilibrium temperature increase resulting from CO_2-equivalent doubling between 1.5-4.5 degrees Centigrade. A recent survey of 18 general-circulation model simulations (GCMs) from seven different modeling groups found an average warming (from CO_2-equivalent doubling) of 1.9-5.2 degrees Centigrade. As Nordhaus notes, the range is uncomfortably wide, and is not narrowing.

55. Estimating the rate of temperature increase requires estimates of both the rate of increase of greenhouse gas emissions and the resulting climatic effect. Because the uptake of heat by the ocean will delay atmospheric warming by several decades, equilibrium experiments are misleading if taken as forecasts of actual climatic change. To illustrate, note that current greenhouse gas concentrations have already reached a level that, when in equilibrium, should lead to half of the effect of a greenhouse gas doubling. Yet, warming over the last century is clearly far less, probably a maximum of 0.5 degrees Centigrade.

56. The Amazon primarily generates greenhouse gases through tree-burning, which releases carbon dioxide (CO_2) into the atmosphere./19 Deforestation is just one of many sources of carbon dioxide, however, and carbon dioxide is only one of several important greenhouse gases. To put the actual and potential contribution of Amazon fires to greenhouse gases into perspective, therefore, we need to know the actual and potential net liberation of CO_2 into the atmosphere resulting from conversion of forest land to other uses, and the relative importance of CO_2 to global warming.

57. Despite the close association in the public mind between deforestation in the Amazon and global warming, the actual contribution turns out to be modest relative to other sources, and only estimable to a rough order of

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/19 Note that contrary to widespread belief mature (terminal) tropical forests are not net absorbers of CO_2.

magnitude. According to Worldwatch (1989), the 1988 contribution to atmospheric carbon from deforestation (worldwide) was between a lower limit of 7% and an upper limit of 31% of the total./20 This large range of estimates is partly caused by the difficulty of obtaining accurate estimates of actual burning rates. It also reflects, however, different interpretations concerning the amount of burning actually taking place, the amount of biomass in the forest, and the completeness of the burn.

58. Calculations can be based on Fearnside's reviews (1986, 1987) of the amount of carbon loss (in forest and soil) in the conversion of land under dense tropical forest to pasture. They yield a net loss on the order of 12,400 metric tons per km^2. Burning in the Amazon averaged 21,000 km^2 per year, over 1978-89 (Fearnside et al, 1990) and this would lead to a maximum potential atmospheric carbon emission of approximately 260 million metric tons per year. This is a maximum estimate because it assumes that all burning occurs in dense tropical forest and that all carbon lost is converted to gas--viz it ignores the carbon that remains in the agricultural products produced by conversion. Combining this estimate from Brazil with estimates from the rest of the world in 1989 (from Houghton, 1990), the total release of carbon from forest burning becomes on the order of 2.2 billion tons a year. Add to this the burning of 5.5 billion tons of fossil fuels a year (reported by Worldwatch 1989), and annual global carbon emissions total 7.7 billion metric tons--of which the burning of the Brazilian rainforest contributes approximately 3%./21

59. As shown in Table I-13, carbon accounts for about half of total greenhouse gases. The share of any gas in the greenhouse effect is determined by its concentration in the earth's atmosphere and its intrinsic capacity to absorb infrared radiation. Gas concentration is determined by past and present flows into the atmosphere, as well as by the length of time the gas stays in the atmosphere (some gases may undergo decomposition , absorption, or chemical reactions). Based on these factors, carbon dioxide accounts for approximately 50% of total cumulative greenhouse contributions, with methane and chlorofluoro ·bons (CFCs) contributing an additional 36%. Carbon dioxide's relative contribution to the additional greenhouse effect from additional flows (based on 1985 data) has diminished somewhat to 46%, with the role of CFCs rising sharply from 17% to 24%.

60. Combining the share of Brazilian deforestation in total carbon dioxide emissions (3% of the total) with carbon dioxide's share of the overall greenhouse effect (46%), yields a reasonable estimate of Brazil's contribution to the total greenhouse effect on the order of 1.5%. Other greenhouse gas influences may also be present, but their influence appears to be largely

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/20 These ranges are based on 5 billion tons of carbon from fossil fuels, estimated by Worldwatch and estimates of 0.4 billion tons and 2.5 billion tons from deforestation estimated by Detwiler and Hall (1988) and Houghton (1987), respectively. These figures are reported in Worldwatch (1989).

/21 Haughton's (1989) estimate for total carbon emissions from deforestation is 1.4 Bmt per year. Houghton puts Brazil's share at 450 mmt. This estimate uses 50,000 km^2 per year as the Brazilian deforestation rate and 90 tons of carbon per hectare liberated compared to the 20,000 km^2 deforestation rate and 124 tons carbon per hectare used above.

Table I-13: NET ENHANCEMENTS OF THE GREENHOUSE EFFECT

Compound	Atmos. Conc. (1985) (parts per) million) (1)	Annual Increase (1985) (%) (2)	Atmos. Life span (approx.) (Years) (3)	Relative Greenhouse Efficiency (CO_2=1) (4)	Past Cumulative Greenhouse Contribution (%) (5)	Present Marginal Greenhouse Contribution (%) (6)
Carbon Dioxide (CO_2)	346 /b	0.4	100 /a	1	50	46
Chloroflourocarbons (CFCs)	0.001	5.0	100 /d	15,000	17	24 /c
Methane (CH_4)	1.70	1.0	10 /d	32 /d	19	18 /d
Tropospheric Ozone (O_3)	0.02	0.5	0.1	2,000	8	7
Nitrous Oxide (N_2O)	0.30	0.3	10	150	4	5

Source: Arrhenius (1990).

/a The estimated lifetime of atmospheric carbon dioxide assumes dynamic oceanic/atmospheric equilibrium conditions, unlike that of other greenhouse gasses which is largely determined by chemical breakdown (Bach, 1988). The statistical lifespan calculated as the average atmospheric lifetime of a single carbon dioxide molecule as a result of physical removal processes is 4 years (Laut, et al, 1989).
/b Pre-industrial concentration: 260 parts per million.
/c For chlorofluorocarbons presently in use. These estimates may vary, with compensating shifts in the average breakdown of Col. 6.
/d These estimates may vary with compensating shifts in the percentage breakdown of Col 6.

speculation./22

61. Nordhaus' work (1990a) provides the basis for a rough estimate of the social value of preventing carbon dioxide emissions from forest burning. Following a review of the climate sensitivity of economic activity worldwide, and the cost of adapting to global warming over the 80 years that the doubling of CO2 in the atmosphere is likely to take, Nordhaus estimates that it would be efficient (current marginal reduction costs approximate discounted future adaptation costs) to pay in the range of US$3-13 per ton to reduce current carbon

/22 Some argue, for example that deforestation for cattle pasture carries a double impact, because the anaerobic digestion of ruminants is an important source of methane production. A look at the magnitude is instructive, however. A cow discharges approximately 200 grams per day of methane. There are currently fewer than 7 million cattle in the Amazon. This suggests that the total methane contribution of the existing herd in the Amazon is on the order of half a million tons. This compares to approximately 500 million tons given off each year by bogs, marshes, rice paddies, and other sources and an additional 50 million or so that is estimated to leak from natural gas pipelines. An additional possible effect has been identified by some 80 scientists that took part in the Amazon Boundary Layer Experiment (ABLE) designed to identify the gas emissions from the Amazon. They found that as much as 40% of the world's nitrous oxide rises from the wet, humid tropics. They conclude that the main effect of the rainforest itself on the global atmosphere is to release two of the most important greenhouse gases, nitrous oxide and methane, during the dry season (Reported in New Scientist, 16 June, 1988).

emissions./23 Nordhaus chooses US$5 per ton CO_2 as "an illustrative intermediate figure." Combining these values with Fearnside's (op. cit.) estimates of carbon sequestered in dense tropical forest (on the order of 120 tons per hectare), the current value of carbon sequestered in tropical forest emerges at US$1,300-5,700./24 Based on these figures we will use US$2,200 per hectare of tropical forest as a reasonable value of the (global warming) value of preventing burning. Using Nordhaus' US$5 per ton illustrated value for CO_2, and high value of $300 for land in Rondônia, the value of carbon sequestered exceeds by a factor of 7 the market value of agricultural land.

G. Local and Regional Externalities

Effects on Microclimate and Hydrologic Cycle

62. The effect of deforestation in the Amazon on the region's microclimate has raised considerable concern. In the Amazon, far more than elsewhere, rainfall is derived from water recycled into the atmosphere through evapo-transpiration, rather than being blown into the region in the form of clouds from the ocean (Fearnside, 1984). According to Salati and Vose (1984), reduced evaporation and precipitation within the Amazon Basin would reduce the source of water vapor for neighboring regions, including Brazil's agricultural breadbasket, the Central-South Region.

63. A recent attempt to model the interaction between microclimate and land use change was undertaken at the Center for Ocean-Land-Atmosphere Interactions at the Department of Meteorology, University of Maryland (Shukla, Nobre, and Sellers, 1990). The model, which assumed complete replacement of the Amazon forest by degraded pasture predicted that the dry season would lengthen so much that it would be impossible for the rainforest to reestablish itself./25

64. Current evidence, however, suggests that vegetation grows again after deforestation much more rapidly than is commonly believed. This, in turn, heavily impacts analysis of the microclimatic effects of deforestation. Nepstad, in his research in Paragominas, has found that deforested fields used as pasture for one year and abandoned for eight years regained about one third (or 80 tons) of the original forest vegetation (21-25 tree species). Plots which had been

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/23 This analysis assumes that the discount rate on goods and services exceeds the growth rate of the economy by 1% per year. An efficient tax of US$3.2 per ton CO_2-equivalent emerges if the damage from a doubling of CO_2 is 0.25% of total world output. If the damage is 1% of world output, the efficient tax works out to US$12.7 per ton.

/24 Note that 120 tons of carbon in the forest translates into 440 ton CO_2 equivalent. This is so because the molecular weight of elemental carbon is 12, while that of CO_2 is 44.

/25 Unfortunately, the scientists inadvertently left the sea-surface temperature distributions fixed at the mean values for December throughout the simulated years. This makes it difficult to draw any conclusions about the global climatological effects of deforestation from this study.

grazed for six to eight years, as is more commonly the case in Paragominas, had regained about 10% of the original vegetation (16-19 tree species) after being idle for eight years. In addition, some 90,000 km^2 of regrowth forest deforested in the 1960s was, prior to advances in satellite image interpretation in 1989, not even distinguishable from primary forest. Clearly, it is important not to underestimate the forest's ability to reestablish some, if not all, of its environmental functions (biodiversity will definitely be lost unless conscientiously managed).

65. In addition to global externalities, deforestation and development in the Amazon may have local and regional environmental effects of great economic significance, notably local climate and damage imposed downstream from areas experiencing rapid deforestation and/or placer mining. As newly denuded soil is exposed to tropical rainfall, or the river bed is mined, silt and sediment are created. This can have serious consequences for downstream fisheries and downstream dams and reservoirs. Depending on the nature of secondary cover, large-scale deforestation could cause major changes in the hydrology of the Amazon watersheds, including a much higher percentage of precipitation running off the land in the form of groundwater. That would cause dramatic changes in the flooding pattern of the Amazon river.

66. To date, no systematic analysis has documented either the physical or economic changes in watershed characteristics caused by deforestation and mining activity. Yet, from a policy standpoint, these watershed-level externalities are much more tractable than are global environmental effects. In many other countries, watershed authorities have been established under similar circumstances to establish rules for maximizing the overall productivity of the watershed.

67. Technically, any such effort would require a relatively good understanding of the relationship between human activity and the initial displacement of resources;[/26] the delivery of the "pollutant" to areas where it causes damage; and the relationship between the quantity and timing of the "pollutant" delivered and the economic cost of the damage it imposes downstream. In the case of soil erosion and sediment pollution, for example, corrective policies would require knowledge of: (i) the relationship between deforestation (and subsequent land use) and soil erosion; (ii) the extent to which erosion at a given location is likely to lead to sediment pollution in a watercourse; and (iii) the economic damage imposed by sediment pollution in the watercourse, including effects on fisheries, river transport, and water retention structures.

68. At the political level, watershed-level institutions require some mechanism for inducing upstream agents--likely to be imposing damage--to cooperate with downstream agents who would suffer from it. Current federal legislation in Brazil provides a precedent for watershed management. Law number 7-754 (14/04/89) requires the permanent preservation of forest and other natural vegetation at the origin (nascentes) of rivers. Within these areas, a Paralelograma de Cobertura Florestal (PCF) must be established, within which deforestation and other forms of land alteration are forbidden. The dimensions of these PCFs are to be fixed by the regulatory process.

/26 Pollution is perhaps best defined as a resource "out of place."

H. Review: The Policy Challenge

69. The policy challenge for the Amazon is to maximize net social benefits from the area, but formidable obstacles block the direct translation of this objective into policies and programs. Several broad conclusions emerge. First, the private profitability of an activity in the Amazon is not a sufficient indicator of its social desirability--activities that are financially very attractive from a private, personal point of view may lead to a net loss of social welfare. Second, unless prices are distorted by poor policies, or markets are noncompetitive, private profitability indicates that at least private benefits are being generated, and these do matter. The question is whether there are offsetting social costs. Thus maximizing net social benefits requires that visible benefits deriving from agricultural and mineral production be weighed against less visible but real social costs in terms of environmental losses, and whether alternative land uses would net out better.

CHAPTER II

ECONOMIC DEVELOPMENT IN THE AMAZON: ITS NATURE AND CAUSES

A. Introduction

70. Effective developmental/environmental policies in the Amazon will depend on an accurate understanding of the incentives that currently affect environmentally important economic behavior. This chapter will attempt to contribute to that understanding, and two general themes underlie it: the distinction between geographically stable (sustainable) activities and intrinsically transient activities; and the distinction between policy-driven activity, and that based fundamentally on underlying market forces.

Stability and Sustainability

71. The Bank agrees with the Brazilian authorities on the desirability of sustainable development./27 At the same time, "sustainable development" has proved to be a particularly awkward concept to use in analytic work. This is so because the most widely accepted and quoted definition of sustainable development, that of the Brundtland Commission--"meeting the needs of the present generation without compromising the needs of future generations"--bears little resemblance to its meaning in common usage. Thus use of the term rapidly becomes an impediment to clear communication. In fact, it is likely that the popularity of the term "sustainable development" at the political level stems from the same ambiguity that has driven it from use at the technical level: Environmentalists hear "sustainable" while developmentalists hear "development." The term suggests that "win-win" alternatives are waiting to be discovered.

72. The analysis of this report suggests that the number of "win-win" alternatives in the Amazon may be limited. In particular, the objective of improving the standard of living of the current inhabitants of frontier areas will, more often than not, be in conflict with the objective of reducing their rate of extraction of natural resources to sustainable levels. This result does not diminish the desirability of searching for "win-win" solutions--it only suggests that few are likely to exist, and that special care must be taken to ensure that apparent "win-win" solutions do not ignore any underlying contradictions which may exist. Current and future work in the Bank will seek first to maximize the number of possible "win-win" alternatives and second, to minimize the costs of tradeoffs where they are necessary.

/27 The Bank is working with the Brazilian Government to develop appropriate strategies in several states in the Brazilian Amazon. We are also partners in developing a "sustainable development" strategy in the context of the Pilot Program to Conserve the Brazilian Rain Forest. Precisely because the Bank is an active participant in such projects, it takes particularly seriously the importance of exercising critical, independent judgement, however.

73. The distinction between "stable" and "transient" activities corresponds closely to that generally meant by "sustainable" and "unsustainable" activities when used by physical scientists. When discussing agriculture, for example, a soil scientist would consider a farming activity "unsustainable" if it resulted in a net loss of soil nutrients year after year. At some point this "mining" of soil nutrients would result in yields so low that continued farming on the plot would be impractical, and the farmer would have to either invest in efforts to recondition the soil (principally through fertilizers), move to yet unmined soils, or find a different occupation.

74. At the more general level, when applied to environmental issues, sustainability refers to a system's ability means to provide the same quality of services in the future as it does in the present./28 For example, the farmer mining the soil in an agronomically unsustainable rate in the Amazon could be investing in the education of his family in São Paulo. The loss to society caused by the reduced productivity of the soil in the Amazon could be more than balanced by the social benefits that result from the increase in the human capital of the farmer's family. If so, this is "sustainable" activity, by the economist's definition. Because the term "sustainable" has such a different meaning for economists, physical scientists, and politicians it will not be used here.

Nutrient Mining

75. Transient activity in the Amazon tends to be based on mining, whether the resource being mined is gold, tin, or the nutrients stored in the forest and soils of the Amazon./29 The only difference between mining gold and mining nutrients is that nutrients are removed indirectly, in the form of timber, beans, rice, corn, and beef. In both cases, the activity physically dislocates, whether by premeditation or economic forces, when the resource base is depleted to the point where further efforts at extraction are not justified.

/28 In most tropical ecosystems, the forest vegetation plays a major role in maintaining the fertility of tropical soils, particularly where the substrate may produce poor soils with little nutrient content. Compared to deciduous forest ecosystems, the vegetation of tropical forests contains a greater accumulation of nutrients. Removal of the vegetation, therefore, leads to rapid depletion of the warehouse of nutrients and the soils. Although this storehouse may eventually be restored through the establishment of secondary growth and the regeneration of soils, the nature and timing of this recuperation will depend on the intensity of use and degree of degradation--experiments indicate from decades to centuries. These nutrients are effectively mined on a human-economic time scale.

/29 Although this definition corresponds roughly to adopted by the Brundtland Commission and accepted by the World Bank, it is difficult to use operationally. The difficulty arises from "loopholes" in the definition to allow for the transference of services from one geographical area to another and from one form to another (i.e., natural capital to human capital).

76. Two major factors determine whether a farmer will mine or adopt geographically stable techniques. The first is the relative cost of fertilizer and land,/30 and the second, closely related, the degree of market orientation and the size and proximity of market. Clearly, near a large, stable, urban market, the production of high value crops at low transport cost justifies the use of fertilizer and other investments in stable agriculture. As agriculture moves farther and farther from markets, and land becomes increasingly inexpensive, it becomes cheaper to move to new land than to purchase fertilizers. In sum, distance from market and land abundance cost dictates that, as farmers approach the frontier, it is cheaper to move the farm to the nutrients than the nutrients to the farm./31

77. Environmental policy must distinguish between regions where the economies are fundamentally transient,/32 and others that have a geographically stable base. The interest on the part of local authorities in enforcing restrictions on non permanent techniques, whether in timber, agriculture, or ranching, will depend on the size and viability of the geographically stable economic base.

Fundamentals and Policy-Driven Activity

78. The second theme of this chapter is the distinction and balance between policy and "fundamental" incentives activities in the Amazon. For example, the abundance and consequent low cost of land in the Amazon is a fundamental incentive for cattle raising, but tax write-offs for investment in cattle ranches constitute a policy incentive. In general, the quality of data and the complexity of economic interactions and regional differences do not permit any clear evaluation of the relative importance of policies and fundamentals. In most cases, however, eliminating the distorting policies will not fully eliminate the incentives to engage in environmentally undesirable activities.

/30 To the extent that land title is not endogenous (secure land rights emerge when land values can justify them) secure land rights should be added as a third factor. Almost by definition, at the frontier (the economic margin), the value of land does not justify the evolution of land contracts.

/31 The issue of choice of agricultural technique in land-abundant economies has been studied with insight by Ester Boserup (1965). Essentially her conclusion is that rural people will only move to more land intensive techniques--from forest fallow, to bush fallow, to settled agriculture--under the duress of increasing population pressure. Although in general, in modern society the benefits of more permanent location may somewhat reduce the willingness to move, many Amazonian communities offer little advantage to stability. Indeed, in many cases the whole community may be best characterized as in a constant state of transience.

/32 It is ironic that in the case of the Amazon, the mining economy of the Carajás, with mineral reserves equal to an estimated 500 years production, must be considered one of the most geographically stable economies of the country.

Table II-1: INDICATORS OF THE IMPORTANCE OF MAJOR ECONOMIC ACTIVITIES IN THE NORTHERN REGION

Activity	Participation	Area Involved	Economic Value	Comments
Ranching and livestock	Nearly 100,000 people involved in raising cattle. Over 80% involved in integrated agriculture with fewer than 100 head.	Nearly 100,000 km^2 in forested areas, another 40,000 km^2 in natural pasture.	Approximately one fourth of agricultural value added	There are approximately 7 million head of cattle in the northern region (4.2% of the national herd)
Loggers	4,000 licensed sawmills	Mostly frontier Pará and Rondônia	13% of industrial production of the Amazon	Growth from 4.5 million cubic meters of log production in 1975 to 24.6 in 1987.
Small Farmers	1,800,000 people employed on farms smaller than 100 hectares in north (1985)	Approximately 70,000 km^2 in the north (1980)	—	—
Garimpeiros	650,000 to 800,000	170,000 km^2	$13 billion between 1980 and 1988	Only 20-30% goes through official channels
Extractivists	Fewer than 200,000 of which over 100,000 are tribal	112,000 km^2	$40-50 million in 1984	65% of the value of production is rubber
Large-scale Mining	—	10-15,000 km^2 actually being mined	$1 billion in 1987	Mineral wealth of the Amazon estimated at $3 trillion.
Hydro-Developments	—	Upper limit of 100,000 km^2 if all potential hydro development were to take place (currently 5,445 km^2).	98,000 megawatts hydroelectric potential	Revisions of Brazil's hydrodevelopment plan have reduced planned development by 6,500 megawatts.

The Actors

79. This chapter will review seven types of economic activity in the Amazon. These are summarized briefly in Table II-1. Volume II of this report contains appendices describing these activities in more detail, and provides the basis for the analysis in this chapter. Generally transient activities are (i) cattle ranching, (ii) logging, (iii) small scale farming, and (iv) placer mining

(garimpagem).[33] Geographically stable activities are (i) ecologically-sound forest product extraction (extractivism), (ii) large-scale mining, and (iii) hydroelectric development.[34]

Table II-2: GROWTH OF CATTLE IN THE NORTHERN REGION, 1920-87

	1920	1940	1950	1960	1970	1975	1980	1985
				Head of Cattle				
North	869,108	999,041	1,020,305	1,234,882	1,706,127	2,129,609	3,989,113	5,358,578
Pará	615,481	705,524	735,529	844,740	1,043,648	1,441,851	2,729,796	3,485,368
Amazonas	238,449	270,180	87,440	141,424	263,437	203,437	355,748	420,940
Acre	15,178	23,337	25,020	32,516	72,166	120,143	292,190	333,457
Amapá	..	..	31,010	45,476	64,990	62,660	46,079	46,901
Rondônia	..	..	2,052	3,475	23,125	55,392	251,419	768,411
Roraimá	..	..	139,254	167,251	238,761	246,126	313,881	303,501
				Average Annual Rate of Growth				
North	--	0.7%	0.2%	1.9%	3.2%	4.4%	12.6%	5.9%
Pará	--	0.7%	0.4%	1.4%	2.1%	6.5%	12.8%	4.9%
Amazonas	--	0.6%	-11.3%	4.8%	6.2%	-5.2%	11.2%	3.4%
Acre	--	2.2%	0.7%	2.6%	8.0%	10.2%	17.8%	2.6%
Amapá	--	--	--	3.8%	3.6%	-0.7%	-6.1%	0.4%
Rondônia	--	--	--	5.3%	19.0%	17.5%	30.3%	22.3%
Roraima	--	--	--	1.8%	3.6%	0.6%	4.9%	-0.7%

Source: Agricultural Census, 1940, 50, 60, 70, 80 and preliminary census for 85.

Note: Rondônia, Roraima and Amapá were created in 1943. Previously, the data for the first two were incorporated in Amazonas and that of Amapá was incorporated in Pará. This explains the sudden fall for Amazonas between 1940 and 1950.

B. Transient Activities

Ranchers and Cattle Owners

80. Introduction. Approximately 100,000 km^2 of native forest have been converted to pasture over the past 30 years, allowing the number of cattle in the north to grow from 1 million in 1950 to over 5 million in 1985 (Table II-2). Much of this growth was encouraged by government policies in the form of fiscal

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/33 As will be seen in the following text, this typology is a broad generalization that simply facilitates the exposition of these activities. Clearly, some degree of geographically stable logging is possible and geographically stable examples of small-scale farming are identifiable. As will be seen, the value of this generalization lies in the illustration of the difficulty of making these activities geographically stable in the face of strong and fundamental economic incentives to the contrary.

/34 Large scale mining is classified in this typology as essentially geographically stable within the Amazonian context (and on a human socio-economic time scale) because of the extremely large deposits of minerals found there. For example, at current levels of production, the Carajas deposit is predicted to have more than 100 years of iron ore production.

incentives, tax policy, and land tenure policy (Mahar, 1989; Binswanger, 1989). To the extent that these policies were the major determinant of growth in the cattle industry, recent policy changes can be expected to discourage ranching in the Amazon. However, data from the agricultural census indicate that the most rapid growth has taken place in small farms that were unlikely to have received government assistance.

81. Growth by Herd Size. Table II-3 shows the breakdown of the growth in cattle numbers in the north between 1980 and 1985 by size of herd. The data show that for the north as a whole (right had column of the table), there is a clear inverse relation between the size of herd and the rate of growth. Herds smaller than 50 head represented (in 1985) 17% of all cattle in the north, and grew over 70% between 1980 and 1985. Cattle in herds of between 50 and 500 head represented 38% of all cattle and grew at an average of about 47%. More than 45% of all cattle in the north were in herds of over 500, but these grew only 17%. Only in Rondônia, which had by far the highest rate of cattle growth in the region, did this inverse relationship not prevail. Roraima, lost 2% of its cattle overall--all from herds larger than the 200; the number of cattle in herds smaller than 200 grew by 80%.

Table II-3: CATTLE IN THE NORTHERN STATES: COMPOSITION BY SIZE OF HERD (1985) AND RATE OF GROWTH BY SIZE OF HERD, (1980-85)

	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)	Comp. (%)	Growth (%)
<10	6	154	6	26	4	42	1	160	2	60	2	66	3	72
10 to <20	9	202	7	26	7	20	1	134	3	66	5	26	4	77
20 to <50	20	241	11	35	15	12	4	94	8	52	15	31	10	70
50 to <100	16	254	10	36	15	4	5	42	8	35	16	-7	10	51
100 to <200	13	248	9	28	15	-3	8	-8	12	61	16	-2	12	56
200 to <500	11	130	14	29	20	23	27	3	15	40	19	-11	16	37
500 to <1,000	7	111	10	9	9	18	30	-6	12	20	13	-37	12	18
1,000 to <2,000	6	254	10	-3	7	12	14	-36	10	3	15	432	9	6
2,000 and more	11	257	24	-5	9	169	8	26	30	14	0	-100	24	20
Total	100	206	100	14	100	18	100	-3	100	28	100	2	100	34
Addendum: 1985 herd size (head)	768,411		333,457		420,940		303,501		3,485,468		46,901		5,358,678	

Source: 1985 Preliminary Agricultural Census.

82. Direct Government Incentives. The two forms of direct government incentives to livestock production in the north have been subsidized credit and regional fiscal incentives. Taken together, these have represented on the order of US$300 million per year over the period 1970-88 (Table II-4). The fiscal incentive takes the form of a tax credit equal to the investment for firms willing to invest in approved projects in the north. Unlike the fiscal incentive, agricultural credit is available throughout the country; the north region receives 3-4% of Brazil's livestock credit.

83. Size Bias of Government Incentives. Both forms of incentives are biased towards large farms. SUDAM-approved projects averaged 13,375 hectares in

size in 1989. Pará, which received some 70% of the SUDAM livestock projects in the northern region, had an average project size of 9,500 hectares in 1988. According to the preliminary 1985 agricultural census, Pará had 289 livestock operations larger than 5,000 hectares (out of 11,175 operations). SUDAM-approved projects in 1985 numbered 253--suggesting that nearly 90% of the farms over 5,000 hectares received incentive payments. Although no comparable data is available for livestock credit, the large-farm bias of subsidized agricultural credit is well established: Demand exceeds supply and allocation becomes based on minimizing transaction costs, viz making relatively few large loans. In 1985, for example, only about 6% of the livestock enterprises in the north received credit from official sources.

Table II-4: DIRECT INCENTIVES TO LIVESTOCK FISCAL INCENTIVES (FINAM) AND SUBSIDIZED CREDIT 1971-87 (In Millions of 1990 US$)

Year	Fiscal Incentive	Livestock Credit	Total	Real Interest (%)
1971	345	35	381	-5.8
1972	214	72	285	-2.7
1973	131	89	220	-2.6
1974	209	76	285	-16.4
1975	238	151	389	-13.0
1976	265	229	494	-23.0
1977	108	152	261	-17.8
1978	134	164	298	-19.0
1979	88	183	271	-35.6
1980	102	99	201	-38.8
1981	174	97	270	-25.6
1982	250	137	387	-27.3
1983	134	91	225	-36.1
1984	168	53	221	-1.6
1985	153	52	204	-3.8
1986	303	204	507	-35.5
1987	156	100	256	NA

Sources: Central Bank of Brazil and "Anuário Estatístico do Brasil.

Note: Deflated by IGP-DI to 1977. Then converted to 1990 US$.

84. Table II-5 estimates the maximum number of cattle that could have been on ranches benefitting from subsidized credit and fiscal incentives in 1980 and 1985. This upper limit is generated by assuming that fiscal incentives and subsidized credit are preferentially given to the largest farms. For the north as a region, the results are as follows: subsidized credit covered 78% of cattle in 1980 and 63% in 1985 (on 13% and 6% of the ranches, in 1980 and 1985, respectively) received official credit; SUDAM-FINAM incentives covered 17% of the cattle in 1980 and 25% in 1985 (on 0.2% and 0.4% of the ranches, respectively) received transfers. Comparing Tables II-5, and II-3 leads to the conclusion that the most dynamic sector of the nc .th's livestock industry is not the large farm sector receiving subsidies, but farms with fewer than 100 cattle which generally received neither subsidized credit nor SUDAM-FINAM incentives. Table II-3 shows that the number of cattle on farms containing fewer than 50 head of cattle increased 72% over the period 1980-85, while the number on ranches with 500 or more cattle increased by only 17%. From Table II-5, on the other hand it can be seen that none of the small farms are likely to have received either official (subsidized) credit or fiscal transfers, while virtually all of the large farms would have received official credit and many would have benefitted from fiscal transfers as well.

85. Ineffectiveness of Government Incentives. Why has growth been relatively slow on the farms that have received government transfers? Three factors probably explain the lack of dynamism of the large farm sector: (i) some were uneconomically large; (ii) some attempted to use agronomic techniques that were not viable; and (iii) many were not serious farms in the first place.

Table II-5: MAXIMUM NUMBER OF CATTLE ON FARMS BENEFITING FROM FINAM INCENTIVES AND OFFICIAL CREDIT, 1980 AND 1985

	Cumulative % Total													
	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Estab./a	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle
	1980													
< 10	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10 to < 20	46.6	92.2	43.5	94.3	67.6	96.6	84.6	99.7	60.9	98.5	83.2	98.8	58.1	97.7
20 to 50	27.1	82.9	23.5	87.8	45.6	90.2	74.0	99.1	44.6	96.0	64.0	95.1	40.1	94.3
50 to < 100	10.2	65.0	10.3	78.3	21.7	74.4	60.5	97.2	24.2	89.2	36.2	83.3	20.8	86.1
100 to < 200	4.4	51.1	5.4	70.2	10.1	57.5	48.4	93.5	13.8	81.5	17.0	66.1	11.6	77.3
200 to < 500	2.1	40.1	3.0	62.5	3.9	39.5	34.2	84.8	7.4	72.0	8.2	49.7	6.1	67.1
500 to < 1,000	0.6	25.0	1.3	50.2	1.0	20.7	15.0	59.1	3.1	57.9	2.4	28.4	2.5	51.7
1,000 to < 2,000	0.2	14.9	0.7	40.1	0.3	11.4	4.3	27.6	1.4	45.1	0.3	7.4	1.0	38.0
2,000 and more	0.1	9.6	0.4	28.7	0.1	4.0	0.6	6.3	0.6	33.3	0.2	4.6	0.4	26.4
	1985													
< 10	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
10 to < 20	54.2	93.6	44.2	93.7	61.4	96.0	75.5	99.2	61.7	98.1	78.1	98.0	58.3	97.1
20 to 50	32.8	84.3	24.5	86.6	40.2	89.5	59.8	97.7	43.5	94.9	57.9	93.5	38.8	92.6
50 to < 100	12.3	64.3	10.3	75.3	18.3	74.4	41.4	93.9	22.5	86.7	27.1	78.3	18.5	82.2
100 to < 200	4.8	48.3	5.2	65.6	8.6	59.5	29.9	88.5	13.1	78.6	13.3	62.6	9.9	72.3
200 to < 500	1.8	35.7	2.8	57.1	3.8	44.8	21.2	80.2	6.4	66.6	6.1	46.7	4.8	60.5
500 to < 1,000	0.6	24.3	1.1	43.1	1.0	25.2	8.6	52.7	2.4	51.2	1.8	28.0	1.7	44.7
1,000 to < 2,000	0.2	17.4	0.5	33.5	0.4	16.0	1.9	22.3	1.0	39.2	0.7	15.0	0.7	32.7

Table II-5: MAXIMUM NUMBER OF CATTLE ON FARMS BENEFITING FROM FINAM INCENTIVES AND OFFICIAL CREDIT, 1980 AND 1985 (cont'd.)

	Cumulative % Total													
	Rondônia		Acre		Amazonas		Roraima		Pará		Amapá		North	
	Estab./a	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle	Estab.	Cattle
2,000 and more	0.1	11.3	0.2	23.8	0.1	9.0	0.4	8.2	0.4	29.7	0.0	0.0	0.3	23.6
Memorandum Items:														
No. of units, 1980	8,906	251,419	7,037	292,190	7,571	355,748	1,345	313,881	29,362	2,729,796	619	46,079	54,840	3,989,113
No. of units, 1985	24,639	768,411	9,036	333,457	9,534	420,940	2,058	303,501	44,175	3,485,468	757	46,901	90,199	5,358,678
Credit contracts, 1980	471	--	159	--	1,105	--	485	--	4,653	--	64	--	6,937	--
Credit contracts, 1985	1,044	--	488	--	971	--	327	--	2,619	--	11	--	5,460	--
Percent with contract, 1980	5.3	53.2	2.3	57.2	14.6	64.0	36	85.9	16	83.0	10	53.6	13	78.4
Percent with contract, 1985	4.2	46.0	5.4	66.1	10.2	61.9	16	68.7	16	80.9	1	23.7	6	63.3
FINAM projects approved, 1980 /b	2	--	4	--	21	--	1	--	105	--	3	--	136	--
FINAM Projects approved, 1985 /b	11	--	20	--	31	--	8	--	228	--	29	--	327	--
Percent with FINAM incent., 1980	0.0	3.2	0.1	4.4	0.3	9.8	0.1	0.8	0.4	20.6	0.5	21.3	0.2	16.5
Percent with FINAM incent., 1985	0.0	5.9	0.2	22.7	0.3	15.0	0.4	8.2	0.5	31.1	3.8	36.8	0.4	25.4

Source: 1985 Preliminary Census, SUDAM (in Yokomizo, 1989), Banco do Brasil, and Ministry of Finance.

Note: Farms under the upper line are likely to have received subsidized credit. Those under the lower line are likely to have received FINAM regional incentives (except for Amapá in 1985 when there were more FINAM projects than credit contracts).

/a Number of establishments.

/b Cumulative number of projects approved to date.

86. Up to the end of the 1970s the belief prevailed that only very large ranches could achieve economies of size in the Amazon. FINAM projects larger than 100,000 hectares were established, with one greater than 300,000. Supervision of projects this size under Amazonian conditions proved impossible. Many were later divided into smaller enterprises. Others were invaded by squatters and ultimately broken up, while still others were abandoned (Yokomizo, 1989).

87. Some ranches did try to introduce modern, agricultural techniques, including pasture fertilization and the reseeding of pasture that will not eliminate the need for transience. Simulations by Hecht, Norgaard, and Possio (1989) show that "modern" techniques with relatively high input are financially profitable only in unusual conditions, when there are high beef prices, low input prices, and increasing land values (which would, of course, have to be realized through sale). Traditional biologically unsustainable overgrazing was always more financially profitable. Attempts to apply "modern" technology are usually associated with large (and often absentee-owned) operations, rather than small operations in closer touch with local conditions.

88. Finally, it is legitimate to ask whether many large ranches were ever serious cattle operations, or whether public benefits could be received without actively raising cattle--in effect, the ranching of incentives not cattle. Binswanger (1989) reviews the five categories of benefits bestowed on agriculture in the Amazon:

(a) agricultural income is almost entirely exempted from income taxation, making agriculture a tax shelter;

(b) rules governing the allocation of public land encourage deforestation, because the rules to determine the security of a claim and its geographical limits encourage land clearing;/35

(c) the progressive land tax contains provisions (designed to promote land "improvements") that encourage the conversion of forest to crop land or pasture;

(d) there are tax credits directed toward corporate livestock ranches (fiscal incentives); and

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/35 Land allocation rules were altered under Nossa Natureza (1989) in order that burning would not be recognized as proof of occupation and use of land in the granting of title. However, it is understood that the National Institute for Agrarian Reform (INCRA) still applies a qualifying criterion of "economic exploitation" when granting title. This may imply that deforestation takes place prior to the establishment of productive activities, thus implying indirectly that deforestation is still a condition of titling. In Amazonas state, an informal arrangement between INCRA and IBAMA allows the latter to inspect land title applications in an effort to avoid deforestation taking place specifically in order to gain title.

(e) subsidized credit is available to SUDAM-approved ranches and private farmers who have titles or other land documents recognized by the credit institution.

89. None of these benefits directly subsidizes the output--cattle. In effect, they provide money at below market (generally negative) real interest rates if the applicant can show evidence that he has a qualified agricultural establishment. Experience with subsidized inputs worldwide, and subsidized credit in particular, has taught a clear lesson that unless the subsidy is directed to the most profitable use of the input, markets will soon evolve to divert its use./36 The more liquid the input the easier the diversion. In the case under consideration, the subsidized input is money and financial markets are well developed.

90. The incentives industry did not rely on actual cattle production. It was more important to have the legal structure of a ranch and to be well-represented in legal and financial circles. Thus, in areas where it was less profitable to produce cattle than to collect transfers and invest them elsewhere, cattle were not produced. Gasques and Yokomizo (1985, p.26) suggest that this took place with the collusion of the financial and regional authorities granting the incentives. Those, on the other hand, who found ranching to be the most profitable use of the transfers invested the money in the cattle operations. However, to access the incentives, only the minimum legal and physical structure of a ranch, and an agreed plan of implementation was required. As will be discussed below, actual implementation was in fact not enforced.

91. The 1985 IPEA-SUDAM-BASA field survey of SUDAM-supported projects (Gasquez and Yokomizo (op. cit.) confirms this distinction between "incentive ranching" and cattle ranching. The findings, which are summarized below, clearly show that for many entrepreneurs, the fiscal incentives system had more to do with commerce in discounted subsidy streams than with cattle production. This outcome rested partly on the authorities' lack of interest in verifying the status of cattle production on the ranches. While some serious cattle enterprises were undoubtedly initiated under the system, it was much more common to find "projects" where the central strategy was to make the minimum expenditure necessary to receive the fiscal incentive, and, where possible, to capitalize the incentive stream quickly through selling the property./37

- Of the 11 projects visited, which were defined as fully "implemented" by SUDAM, three were reported to be functioning as planned; they were profitable and their owners continued to invest

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/36 Subsidies applied to the output, on the other hand have an unambiguous role in increasing output.

/37 It may be argued that even if government transfers did not increase production of cattle significantly, at least the effort to establish a presence on the land must have led to considerable deforestation. It is interesting to speculate, however, whether more deforestation would not have occurred had the large tracts of land left undeveloped by SUDAM projects been instead occupied by a larger number of smaller and more intensely managed ranches (e.g., squatters).

with their own resources. Two were functioning as "Latifúndia" and no longer kept records. Three had disappeared and hardly anyone seemed to remember that there had once been cattle ranches there. Two were abandoned, and one had been invaded by settlers. The last had buildings but no pasture. On average, the projects produced less than 16% of originally planned annual output. Only one produced for other than local markets (approximately 20% of output), and had offtake rates which indicated a commercial operation (36%).

- For most projects analyzed, the fiscal incentives did not change the traditional techniques and relationships substantially. Out of a group of 25 "implemented" projects, only 7 changed the fundamental economic conditions sufficiently for the enterprise to achieve the minimum limits required to be classified by INCA as a "rural enterprise." Of the remaining, 12 were considered "Latifúndio por Exploração" and the remaining 6 had not been legally entered in the cadastre, and therefore legally did not exist--despite being considered fully implemented projects by SUDAM.

- The rate of turnover of projects was high, suggesting more interest in capitalizing the potential stream of incentives than in implementing the project. Many people managed to receive funds for 5 or 6 projects, and after receiving the initial tranche of incentives, sold or abandoned them, practically without initiating the enterprises. Around 30% of the projects were abandoned.

- The frequency with which ownership of subsidized projects have changed hands gives the impression that there is a commerce in contracts for subsidized projects.[/38]

- Projects tend to stay in the fiscal incentive system, in an attempt to obtain further fiscal resources, often by "reformulating" the project. Even though projects should have "graduated" from the system in 8 years, 40% of the projects "under implementation" in 1985 had been in the system between 7 and 19 years. Many had received more than twice the originally planned level of resources.

- For six of the "fully implemented" projects results were available concerning the supervision of projects prior to the liberation of resources. The average length of time between the last attempt by SUDAM to verify project implementation and the last incentive payment was nearly 6 years. On average each project had received 9 payments without verification of implementation progress on site.

92. Other Explanations for Growth in Cattle Numbers. The discussion thus far has shown, first, that growth in cattle numbers has been most dramatic (from 1980 to 85) in herds smaller than 100, and that such herds usually did not benefit from fiscal incentives or subsidized credit. Second, this should not be

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/38 With the huge subsidies involved, the demand for SUDAM contracts clearly exceeded the supply. Contracts could therefore be sold to another buyer--essentially "cashing in" the discounted subsidy stream.

surprising, since owners of large "farms" were often more interested in uses of government transfers other than ranching. The question remains, however, if the small farm sector is not receiving government transfers, why did it grow so fast?. There are four likely explanations; low cost of nutrient mining, continued northward movement of the crop/livestock frontier, the growth of local beef markets, and land speculation.

A direct measurement of pasture converted under fiscal incentives was carried out by INPE (under contract from SUDAM) for the two states which had received the bulk of the fiscal incentives, Mato Grosso and Pará (reported in Yokomizo, 1989). Out of the total of 84,000 km^2 of land occupied by FINAM-supported projects, 70,000 km^2 were these two states. Their study revealed that of the 70,000 km^2, 40,000 was approved for pasture use, and in fact, slightly less than 20,000 km^2 was actually cleared. Total deforestation in these states since 1975 was on the order of 156,000 km^2. Thus, in the area where fiscal incentives had been most concentrated, they accounted for approximately 16% of the deforestation--21% before 1970 in Mato Grosso and 7.5% in Pará (excluding deforestation before 1970). For Pará they accounted for approximately 20% (6,600 km^2) of the growth of land in pasture over the period.

Box II-I: Fiscal Incentives and Deforestation

93. At the low price of new land in the Amazon, mining the nutrients and moving on to new land is a low-cost form of beef production. A simulation by Hecht et al (op. cit.) indicates that this is the most financially robust technique, under a wide range of input and product prices which include the absence of subsidies. This shifting form of cattle ranching may also be practiced more easily on smaller farms.

94. The land price gradient discussed in Chapter I has continued to encourage ranching to move north. The rate at which the crop-livestock frontier advances is determined by the rate at which land-intensive activities (largely wheat and soybean culture) displace land extensive ones. This process has been going on throughout the century in Brazil, with the livestock frontier moving first south from the coastal population centers and into Rio Grande do Sul, and later, as cattle pasture in the south became displaced by higher valued crops, turning north through Mato Grosso do Sul and Mato Grosso.

95. Consider the dynamics of the process. Before the introduction of adapted soybeans into, say, Mato Grosso, pasture was the highest value land use, regardless of the quality of the soil. When soybean culture became possible, soybean farmers were willing to buy the better quality land from ranchers to convert to crop land. The ranchers in turn moved north. This suggests that as the crop frontier reaches land currently under cattle, new sales of cropland should systematically exceed the price brought by new sales of land for pasture. The land price data (for new land sales) are shown in Table II-6. The tendency is especially strong, in Mato Grosso do Sul (MS), Mato Grosso (MT), and Rondônia. These are states where cropland potential is relatively rich by Amazonian standards.

Table II-6: THE LIVESTOCK FRONTIER: RELATIVE VALUE OF LAND IN CROPS AND PASTURE, (1966-87)

	M.S.		M.T.		Pará		Rondônia		Acre		Amazonas	
	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture
1966	97	100	163	100	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1966	117	100	129	100	..	..	..	..	..	..	..	..
1967	146	100	89	100	..	..	..	..	..	..	..	..
1967	92	100	99	100	..	..	..	..	..	..	..	..
1968	59	100	73	100	..	..	..	..	..	..	..	..
1968	64	100	73	100	..	..	..	..	..	..	..	..
1969	108	100	102	100	..	..	..	..	..	..	..	..
1969	147	100	101	100	..	..	..	..	..	..	..	..
1970	133	100	98	100	..	..	..	..	89	100	..	..
1970	159	100	81	100	..	..	..	..	89	100	..	..
1971	135	100	86	100	..	..	..	..	96	100	..	..
1971	118	100	96	100	..	..	..	..	113	100	..	..
1972	114	100	127	100	..	..	..	..	102	100	..	..
1972	147	100	102	100	..	..	..	..	79	100	..	..
1973	132	100	172	100	72	100	..	..	67	100	43	100
1973	111	100	138	100	46	100	..	..	121	100	64	100
1974	86	100	112	100	48	100	..	..	95	100	67	100
1974	121	100	114	100	42	100	..	..	83	100	115	100
1975	116	100	111	100	57	100	..	..	73	100	137	100
1975	116	100	124	100	67	100	..	..	168	100	108	100
1976	104	100	109	100	67	100	..	..	140	100	114	100
1976	108	100	115	100	89	100	..	..	103	100	97	100
1977	112	100	133	100	131	100	..	..	72	100	84	100
1977	157	100	105	100	170	100	..	..	116	100	104	100
1978	137	100	114	100	115	100	90	100	87	100	92	100
1978	149	100	102	100	102	100	91	100	101	100	94	100
1979	149	100	105	100	96	100	95	100	127	100	73	100
1979	146	100	107	100	103	100	94	100	115	100	72	100
1980	126	100	149	100	76	100	98	100	109	100	70	100
1980	137	100	132	100	88	100	90	100	125	100	82	100
1981	156	100	144	100	102	100	104	100	94	100	102	100
1981	175	100	139	100	98	100	99	100	100	100	85	100
1982	167	100	140	100	124	100	94	100	96	100	107	100
1982	179	100	148	100	114	100	99	100	119	100	..	..
1983	190	100	126	100	69	100	119	100	100	100	..	..
1983	189	100	147	100	114	100	133	100	103	100	107	100
1984	201	100	147	100	107	100	117	100	103	100	105	100
1984	200	100	153	100	113	100	107	100	106	100	110	100
1985	191	100	141	100	129	100	124	100	119	100	127	100
1985	178	100	129	100	101	100	115	100	..	..	178	100
1986	171	100	149	100	127	100	140	100	90	100	145	100
1986	182	100	249	100	110	100	151	100	..	..	..	..
1987	165	100	136	100	96	100	139	100	132	100	117	100
1987	173	100	134	100	81	100	155	100	120	100	128	100

Source: Calculated from Data from FGV.

96. While land price dynamics have acted to push cattle reaching north, the expansion of markets in the north has helped to make it profitable. Before the 1960s, cattle production in the north was located primarily on natural pasture near the consumption centers of Belém and Manaus. This natural pasture takes the form of savannah in Roraima and Amapá, natural pasture and floodplains on the island of Marajó in Pará, and the floodplains of Amazonas. The urban population of the north began to expand rapidly in the late 1950s, and these traditional cattle-raising areas could no longer meet local demand (Table II-7).

97. Regional wholesale price data for beef (Table II-8) confirms that the north has not yet achieved self-sufficiency in beef. Wholesale market prices for beef in the north have been 15-45% higher than prices in the south throughout the

period 1976-86. This price differential is clear evidence that beef is generally transported from the south to the north, not vice versa.

Table II-7: COMPARISON BETWEEN GROWTH OF THE CATTLE HERD AND URBAN POPULATION IN THE NORTHERN REGION, 1950-80

	1950	1960	1970	1980	Est. /a 1990
Cattle	1,020,305	1,234,882	1,706,177	3,989,113	8,876,440
Urban population	577,768	968,354	1,625,341	3,042,822	5,002,143

/a For Cattle assumes 1985-87 growth trend continues through 1990. For population the table uses Hakkert's (1990) projection of 9,094,805 people in the north in 1990 and an urbanization rate of 55%.

98. Undoubtedly, land speculation has encouraged ranching as a relatively inexpensive means of occupying land. As discussed in Chapter I, land prices in the south and center-west rose rapidly in the 1970s and 1980s, undoubtedly generating expectations for similar price increases in the north. As shown in Table II-9, however, before the flight to real assets associated with the Bresser Plan in 1986, the southern tier of northern states showed little if any trend toward higher prices. Only Rondônia, with its better quality soils, reflects the trend of price pressure arising from the introduction of soybeans (first in Mato Grosso do Sul (M.G.S.), later in Mato Grosso (M.G.), and currently in southern Rondônia). With this exception, there is little discernable trend in the land price data prior to 1985. This does not negate the possibility that ranches were established in order to capture hoped-for capital gains. It does, however, suggest that these gains were often not realized, and that a rancher making losses would need a very patient banker.

Table II-8: INDEX OF REGIONAL VARIATION IN BEEF PRICES: 1976-87
(Porto Alegre = 100)
(Per Kg)

Region	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Manaus	145	143	148	112	117	112	136	120	116	132	135
Recife	118	129	148	94	104	107	106	96	107	116	112
Rio de Janeiro	91	93	100	75	88	83	91	95	94	101	100
Porto Alegre	100	100	100	100	100	100	100	100	100	100	100
Goiânia	91	86	114	100	90	92	93	99	108	107	100

Source: Preços nos Mercados Atacadistas, Anuários Estatísticos. Ministério da Agricultura, SNAB-CIMAG/SDI.

99. The Future of the Industry. The analysis above suggests that the future of the Amazonian cattle industry will be determined by three factors: (i) the rate of continued urban growth in the Amazon; (ii) the expansion or contraction of the crop-livestock frontier; and (iii) the cost and opportunity involved in opening new land for pasture, or intensifying existing pasture use. In summary form, these factors play out as follows: (i) the rate of urban growth in the north can be expected to slow substantially, except where specific activities draw migrants (e.g. entrepôt and gold mining in Porto Velho); (ii) the

future location of the crop-livestock frontier will depend mostly on trade policy and the development of low-cost transport for crops from the west and northwest; and (iii) continued cattle production in the Amazon basin will depend very much on the competition that beef faces from other meats in consumption, production externalities with the timber industry, the development of better-adapted pasture grasses, and government policy. These issues are elaborated below.

Table II-9: INDEX NUMBERS OF REAL LAND PRICES, MATO GROSS DO SUL
1966 = 100

	M.G.S.		M.G.		Pará		Rondônia		Acre		Amazonas	
Year	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture	Crops	Pas-ture
1966	100	94	74	52	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
1967	104	90	67	71	..	..	..	..	..	..	..	..
1968	96	155	56	76	n/a	n/a	..	..	..	..	..	..
1969	155	122	89	87	..	..	..	..	..	..	..	..
1970	183	125	78	87	..	..	..	..	165	186	..	..
1971	212	168	95	105	..	..	..	..	156	151	..	..
1972	239	182	148	131	..	..	..	..	114	127	..	..
1973	329	272	247	163	67	119	..	..	158	166	122	229
1974	551	527	305	270	71	158	..	..	191	215	171	194
1975	677	584	364	309	116	185	..	..	150	148	221	184
1976	468	441	287	258	96	125	..	..	114	98	163	156
1977	612	458	277	233	180	117	..	..	208	223	144	154
1978	618	433	248	230	145	134	181	200	242	258	161	174
1979	697	472	295	278	126	127	160	170	271	223	129	179
1980	745	568	394	280	126	154	161	171	205	176	138	183
1981	883	534	400	282	132	132	158	156	166	172	157	168
1982	879	508	372	259	162	136	180	186	162	153	101	94
1983	723	393	277	205	133	157	256	205	150	148	56	53
1984	958	478	416	276	138	126	288	259	150	144	171	160
1985	1,279	694	447	333	191	168	401	338	89	74	218	144
1986	1,733	975	742	370	287	247	685	467	84	207	108	237
1987	1,429	853	754	556	235	263	692	479	343	271	226	185

Source: IGV, 1989.

100. As outlined in Chapter I, the tendency towards urbanization is very strong in Brazil, and the underlying factors driving this process affect the north along with the rest of the country. In addition, the mining industry may well grow fast in Pará and elsewhere, as may entrepôt activity in Porto Velho and Itacoatiara (Amazonas).

101. The displacement of cattle ranching in the center-west by soybean culture may be the most important influence on the crop-livestock frontier. This tendency, currently underway, will probably be strongly influenced by two factors: the government's intention to liberalize trade at a market-clearing

exchange rate,/39 and the increasing development of entrepôt activity based on Porto Velho.

102. In terms of the effect on the relative profitability of crops and livestock, the Bank's calculations of protection (IBRD report no. 7798-BR and Forthcoming Livestock Sector Review no. 8570-BR) suggest that soybeans would benefit more from trade liberalization than would livestock. In addition, the effect of lowered transport costs through further development of Porto Velho-based river transport would tend to replace pasture with higher value crop production, especially in Rondônia where soils can easily sustain soybean culture.

103. In sum, conditions are appearing for the development of significant new pressures to push the cattle industry yet further to the north and west. These pressures result not so much from an overall expansion of existing cattle production as from the displacement of cattle caused by higher value land use in crop production. Where current pasture land is technically unsuitable for crop production, as appears to be the case in most of the current frontier with the exception of Rondônia, little displacement will occur. A combination of increased exports and additional displacement in the south should increase the competitiveness of the incipient feeder-calf and refrigerated beef industry in Paragominas (Pará), destined for feedlots in São Paulo and Goiás./40 The same forces will increase refrigerated beef sales from the southern zone of the frontier./41 In Mato Grosso and Rondônia, on the other hand, where significant pasture could be converted to cropland, the tendency will be for existing cattle herds to be displaced onto lower quality lands and primary forest.

104. Profitability of Frontier Expansion. The discussion above indicates that crop production will probably push the livestock frontier northward and westward. Will livestock production continue to survive under these conditions? The answer depends critically on the continued availability of cheap land with access to transport networks. As will be discussed below, the economics of pasture expansion under current technology is tied into a process of joint production with either small farmer agriculture or logging. In the former case, small farmers clear forest, grow several years of annual crops while fertility

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/39 Clearly the notion of a market-clearing exchange rate makes little sense without defining the rest of macroeconomic policy. In this case it is assumed to mean a rate which will lead to an overall balance of payments equilibrium within the context of a Baker Plan type of debt reduction. This exchange rate would probably be substantially more devalued than has been that of the recent past.

/40 The cattle confinement industry is still in its infancy in Brazil. In all of Brazil it is estimated that between 600,000 and 700,000 head were fattened on feedlot during the inter-season in 1989. According to the Associação Brasileira de Confiadores in 1988 the total profit per head of animal confined was on average US$97.

/41 This is also a growing tendency in the south of Pará. For example, one firm alone, FRIPAGO, slaughters and freezes 4-5,000 head a month for shipment to the northeast and São Paulo.

is still high, establish pasture as fertility declines, and sell the land with established pasture to ranchers. With the price of forested land typically 30%-60% that of pasture, the small farmer, using own labor, can make a reasonable return on his annual crops while fertility is high, and a substantial capital gain on his land sale, which is then reinvested into new forest. Where labor is scarcer, or access is poorer (making the marketing of annual crops problematical) ranchers may purchase forest land directly and sell high grade timber to defray the costs of clearing land and establishing pasture.

105. These technologies are a form of mining--there is no presumption or expectation on the part of any of the actors--farmer, rancher, or logger--that the activity is geographically stable. Natural capital is undergoing conversion to financial capital and resources--the forest, soil fertility, and biodiversity --are used up in the process, and, like other forms of mining, if the process is to continue, it must physically change location.

106. Second Generation Pasture Technology. In response to concerns over stabilizing and intensifying northern livestock technology, EMBRAPA has developed several better-adapted strains of pasture grasses, which are estimated to have been applied to over 10,000 km^2 of degraded pasture, largely in Pará. Although these technologies undoubtedly represent significant scientific advancements, and yield longer pasture life and between 2 and 3 times the average weight gain per hectare-year, their economic viability has not been established in practice, except perhaps under conditions of very good management. In Paragominas it is reported that some ranchers have spent income from highgrading forest on pasture regeneration using second generation technology. While they may be making a mistake, these fully commercial ranchers are well aware of the probabilities of success.

107. Summary. In summary, the most rapid growth of the cattle herd in the Amazon has been in the small herds which do not benefit from government transfers. These farms are responding to two major forces; the rapid increase of the urban population during the 1960s and 1970s, and the advance of the crop-livestock frontier. Government policies in the form of fiscal incentives and subsidized credit undoubtedly played a role in overall growth, but were unlikely to have been a major determinant. In fact, as fiscal incentives tended to be directed toward uneconomically large farms, and to businessmen for whom farming was not a serious vocation, land tied up in fiscal incentive projects may have been exploited less intensely than it would have been without the incentives. Subsidized credit, which was widely available, undoubtedly played a role.

108. Expanding cropland will continue to force livestock into the forest. This process will be exacerbated by exchange and trade liberalization, and by the increasing importance of Porto Velho as an entrepôt, with the high likelihood that an Amazonian export corridor will develop. This process will only be limited by government restriction or, more effectively, by limitations on new road construction. Limitations on new pasture would affect meat prices only minimally, as numerous meat production activities could compete adequately in a tighter land market, including confined feeding and poultry.

Logging

109. Introduction. Logging plays a key, strategic role in the current pattern of exploitation of the Amazon, primarily because it opens access to previously inaccessible lands. This role has been encouraged by both a range of public policies and, during the early 1980s, by an extremely strong hardwood market. Despite a worldwide glut in mahogany in 1985, the medium-term prospect is for increasing international demand for South America's tropical wood products.

110. South America's Amazon forest is the most extensive remaining tropical forest on earth. Because of its distance from major international hardwood markets and lack of infrastructure, the pressure from logging, although significant, has been less than that for other major tropical forests such as those in India and Indonesia. As hardwood stock in Asian forests becomes depleted, however, world demand will turn increasingly to South American tropical forests. In addition, Brazilian domestic demand is also turning increasingly to the rain forest as other forests become exhausted.

111. In 1975 only 4.5 million cubic meters (m^3)--or about 14% of Brazil's wood production--came from the Amazon. Twelve years later production from the Amazon had increased by more than a factor of 5.5, to 24.6 million m^3, or 54% of the Brazilian total (Table II-10). Although the Amazon has long been recognized as a rich source of valuable hardwoods, this boom in production resulted from a combination of major government infrastructural development, fiscal incentives, and a sharp rise in international hardwood prices.

Table II-10: LOG PRODUCTION IN MAJOR GEOGRAPHIC REGIONS OF BRAZIL, 1975-84
(Millions of Cubic Meters)

Region	1975	1977	1979	1981	1983	1985	1987
North	4.5	6.7	8.4	13.1	16.1	19.8	24.6
(% Total)	(14.3)	(20.7)	(26.6)	(39.7)	(41.7)	(46.2)	(53.8)
Northeast	5.2	5.3	5.6	6.8	7.2	8.6	8.7
(% Total)	(16.5)	(16.4)	(17.7)	(19.0)	(18.7)	(20.0)	(19.0)
Southeast	2.2	2.0	1.2	1.6	1.7	1.9	1.3
(% Total)	(7.0)	(6.2)	(3.8)	(4.5)	(4.4)	(4.4)	(2.8)
South	16.9	15.3	13.4	10.9	10.2	8.9	7.9
(% Total)	(53.7)	(47.4)	(42.4)	(30.5)	(26.4)	(20.7)	(17.3)
Center-West	2.62	2.9	3.0	3.3	3.4	3.8	3.3
(% Total)	(8.3)	(9.0)	(9.5)	(9.2)	(8.8)	(8.9)	(7.2)
TOTAL	31.5	32.3	31.6	35.7	38.6	42.9	45.7

Source: IBGE, Anuário Estatístico, various years.

112. Annex II reports in some detail on the history and growth of logging in the Amazon and the role of government in its promotion. It describes logging's role in the economies of several communities in the Amazon, evaluates the environmental implications of current practices, analyzes the economics of the policy environment, and makes recommendations for future policies. Readers seeking further details should refer to that annex.

113. Historically, the almost total lack of roads meant that timber extraction in Amazônia was concentrated along a narrow strip of floodplain (varzea). A few species were manually extracted and floated downstream to the sawmill, where they were exchanged for manufactured products. As late as the early 1980s, water transportation was still the primary means of transporting

wood, with 68% of the log volume used by industries being moved in this way (Nascimento 1985).

114. As access improved with road building and frontier development, lumbering expanded and is currently taking place in all major frontier areas of the Brazilian Amazon, particularly in Pará and Rondônia. In general, the economics of forestry dictates that the poorer the access to markets and to labor, the more selective the harvest will be.

115. Government Promotional Policies. Following the 1964 coup, various efforts (promoted by different military presidents) were made to develop the Amazon region. In general, promotion of the forest-based sector was secondary to the promotion of agricultural colonization, ranching, and mining. Nevertheless, several promotional programs were established for both the domestic wood products industry (through the Superintendency of the Manaus Free Trade Zone--SUFRAMA and SUDAM), while an export promotion policy provided subsidies in fixed proportion to the volume of foreign sales the previous year. Even without direct subsidies, however, the relatively easy access created by the extension of roads into the region and the lack of clear laws and effective regulation have made the forestry sector attractive to entrepreneurs.

116. Lumbering and Other Agricultural Activities. As frontier areas have developed over the last five years, the wood industry itself is diversifying both harvesting and processing through the exploitation of a wider range of trees (in terms of size and quality) and species. In general, the frontier lumber industry provides limited amounts of needed supplementary income and infrastructural services to agricultural colonists, ranchers, and fledgling municipalities.

117. Ranching and lumber activities enjoy a particularly close relationship in some older, more developed areas of the Amazonian frontier. The Paragominas area of eastern Amazônia is one such area. Here the wood industry has progressed to a more capitalized stage, justifying the exploitation of a wider range of species. As mentioned above, the local ranching industry has seen its first generation pasture grasses decline over the last 8 to 10 years, and government subsidies for ranching have been sharply reduced. This has also increased interest in diversifying into other activities, further increasing the importance of lumbering in the region, both to underwrite the cost of installing improved pastures, and to acquire new land. Some lumbermen have begun to acquire land as "ranchers" to avoid the complicated environmental impact statements (RIMA) now being required for forestry.

118. Sometimes farmers, ranchers, or even whole municipalities will allow some logging in exchange for road construction services. In the absence of road construction services from the state, this may be the only way for some municipalities to get a road. Lumber roads are, however, usually poorly built, resulting in significant maintenance costs. Of the 272 km of feeder roads built within the agricultural colonization project of Tailândia in Pará, for example, the majority were built by lumbermen. Lumber trucks are also identified as the principal reason for the deterioration of these roads, especially during the

rains. Even though this area is a colonization project, only 1.7% of the feeder roads can be directly attributed to ITERPA./42

119. The Environment and the Economics of Amazonian Logging. There are two environmental criticisms of current logging practices. The first, as described above, is that it hastens the conversion of tropical forest to other uses. The extent to which this is an environmental problem depends upon the importance of the potential environmental externalities reviewed in Chapter I--greenhouse gases, changes in the local microclimate, and loss of biodiversity. The second environmental criticism, reviewed below, emphasizes the apparent "waste" in current lumbering techniques. As we will discuss, much of this apparent "waste" is the outcome of a market where timber is abundant (and cheap) relative to the labor and transport.

120. With appropriate economic incentives, logging can stimulate the growth of the remaining trees rather than damaging them. Whether or not geographically stable forestry techniques will be adopted depends on the relative costs of acquiring new land and of adopting sustainable techniques on existing land. As mentioned above, the economic incentive for geographically stable agriculture of any type in the Amazon is limited by the seemingly endless supply of virgin land./43 In the specific case of timber, this means that labor and transport costs are relatively high compared to stumpage costs. According to Uhl (1989), selective logging rights on a hectare of forest in Paragominas (typically for four to eight trees per hectare) varied from US$25 to US$50 in 1987, compared to US$250 per hectare for the value of cut logs hauled out of the forest. This suggests that the value of the services of the logging team (five people plus bulldozer and chain saw) plus supervision was 4 to 9 times that of the value of the standing tree. For more remote areas, where the cost of logging roads is more expensive, this ratio would be higher still.

121. This large relative cost difference causes the extremely selective logging patterns observed in the remote areas, which minimize machine and labor costs per unit value of timber extracted. It also encourages a lack of concern over the condition of the post-logged forest. This inevitably results in the loss or damage to many potentially valuable hardwood species (as well as those with unrecognized value) by what appears to foresters as the careless and crude methods used to penetrate and extract the target species from the forest. In 1977 it was estimated that as much as 60% of the lumber cut is lost to decomposition as a result of the rudimentary techniques used (see IBGE, Geografia do Brasil: Região Norte, 1977:377).

122. At these relative prices of stumpage and extraction costs, the economics of more careful extraction naturally look unpromising to the logger. As with the farmer and the rancher, low land prices lead to extensive production techniques. Without clear costing of environmental externalities, however, there is little economic justification for imposing "environmental" controls on

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/42 Small farmers who abandon farm plots often give lack of good feeder roads as a principal reason for their action.

/43 This statement should be qualified to reflect the fact that access is required to make the land economically viable.

extraction activity. In the Paragominas area the benefits are particularly doubtful, as remaining trees in selectively logged areas will probably be clear cut for charcoal production and pasture.

123. Improved Logging Techniques. For areas where maintaining forest cover is a high social priority (for instance to protect watersheds or to maintain target levels of biodiversity), least-cost techniques may involve geographically stable forestry. Several techniques are available, although their economic viability under Brazilian conditions would have to be established.

124. Research in Sarawak, Indonesia (Marn and Jonkers 1981 cited by Uhl 1989), has shown that over half of forest damage can be eliminated by more careful extraction. Similar research in Suriname (Jonkers and Schmidt 1984; De Graff 1982) has shown that more efficient extraction can lower the cost of lumber extraction. Careful planning can be used to limit the regrowth of noneconomic species in cleared areas; it can also remove valuable trees in ways designed not to damage other valuable trees (design of logging trails, the direction of fall of trees, and removal of vines that pull down other trees).

125. Building on the concept that controlled forest clearing can stimulate tree growth, a technique has been developed called the "strip shelterbelt system."/44 This effort was tried with some success in the Palcazu Valley of the Peruvian Amazon in a project with Yanesha Indians supported with funds from USAID./45 The strips are used to protect the watershed of a nearby National Park. Moreover, there is an almost total utilization of wood in each strip. Trees are felled with chainsaws and skidded out with oxen to a logging road. Estimated yields of 250 m^3 of wood per hectare is an enormous improvement over the 5 m^3 extracted through more traditional means. This effort is not exactly comparable to commercial timbering described for the eastern Amazon, since the principal objective is not managed extraction of hardwoods for the export market. Currently, most of the wood taken from the strips is converted to commodities for local and national markets.

126. In view of the low cost of Amazonian land relative to labor and capital, it is quite certain that in most instances the overall private return to land, labor, and capital would not be maximized by more labor-intensive, geographically stable techniques. They may play a role in reducing the cost of (and increasing the incentive to) protecting reserve areas, however.

127. Past Policy Initiatives to Regulate Forest Exploitation. Policy discussions concerning regulating forest exploitation have suffered from two basic shortcomings. The proposed polices have ignored the economic incentives that encourage continued use of land-extensive techniques. And the objectives of proposed forest management policies have never been made adequately clear.

/44 This involves the clear-cutting of narrow strips spaced well away from recent clearings. Strips are wide enough to allow sunlight to stimulate the growth of fast-growing species but narrow enough to allow reseeding from the primary forest.

/45 To date, this project has cost USAID about $22 million in research and start-up costs. The main project constraint in recent months has been the ever-widening guerilla war in Peru.

128. In 1965 the first Brazilian Forestry Code was created along with the IBDF (National Forestry Institute under the Ministry of Agriculture) and a system of national forests. The first attempt to expand this model was the Pandolfo Proposal (Nascimento 1985) by SUDAM (1977) intended to "rationalize" wood exploitation in Amazônia.

129. The Pandolfo program, which was never actually implemented, represented the first official proposal for federal government forest policy for Amazônia.[146] Essentially an abortive attempt at land use zoning, the proposal stressed that since soils were generally poor in the Amazon, while many areas were rich in timber, the natural vocation of the area should be wood production and not agriculture (which would be limited to areas of better soil fertility). The plan envisioned the creation of a 50 million hectare network of national forests in Amazônia for managed concessions (called Florestas Regionais de Rendimento) (see Nascimento 1985; 1989).

130. In support of this plan, IBDF completed a study in 1978, concerning the establishment of a system of contracts governing the private exploitation of public lands in Amazônia. This study recommended giving 10-20 year forestry concessions to private companies, which would allow them to exploit the forest under specific management conditions and government supervision. Even though SUDAM fiscal incentives were available, however, there was little interest. Nascimento (1985) claims this was because fiscal incentive programs for cattle were more attractive. In addition, however, it was probably impossible for loggers employing geographically stable forestry techniques to compete in the same market with others using extractive techniques on cheap land.

131. Future Policy Requirements for Amazon Lumber Activities. Appropriate land management policies can be defined only using a clear conception of policy objectives. Past policies were mainly designed to replicate techniques that have proved economically optimal in countries with very different factor proportions, and, hence implicitly (or explicitly) factor prices. The inappropriateness of these techniques for Brazil became obvious to loggers and local authorities and probably largely explains the lack of enthusiasm for their application.

132. Land management policies in Brazil should focus on outcomes, not on land management techniques. The central problems are to define the externality that justifies intervention in the market, and to minimize the (opportunity) cost of obtaining the given social objective.

133. For example, policies with the objective of protecting the world's stock of genetic resources would be very different from forest management policies designed to make Brazilian logging practices resemble those of the

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/146 IBDF, from its creation in 1965, concentrated its activities in administration of a fiscal incentives program for reforestation, primarily concerned with supporting plantations of fast growing species in southern Brazil (Nascimento, 1985; 1989) For this reason, as well as its second-class status within the Ministry of Agriculture, IBDF never took a leadership role in trying to develop a comprehensive forest policy for Amazônia, despite a request for such a proposal during the Figueiredo Administration (Projeto de Lei no.4970 de 1985).

United States more closely. First, they would be highly selective. The justification for establishing a controlled area (reserve) would be clear and explicit, and the type of logging control would correspond to that required to protect the resource. Second, because of its selectivity, a high standard of enforcement would be fiscally feasible. Third, because the value of the protected resource cannot be captured by Brazil, the enforcement cost, as well as the financial opportunity cost of uncontrolled exploitation, should be borne as an international effort.

134. A clear policy must also govern logging in Indian areas. Although technically illegal according to the Indian statute, logging has been documented within the territory of at least 8 different groups./47 Logging in Indian lands has led to violence and death in clashes between Indians and lumbermen and between Indians themselves, since various tribal factions sometimes negotiate deals that are unpopular with others.

135. The Public Finance of Enforcement. The enforcement of restrictions on forest management poses a serious problem of tax competition among various local and state governments. Any restriction of logging or forestry practices is an implicit tax on the forest industry. Local officials, anxious to attract economic activity to their area, have a clear incentive to enforce such legislation laxly, especially in view of the considerable mobility of the timber industry. Thus, competition among various localities for the forest industry will probably erode efforts to impose strict regulatory measures quite quickly. This problem is exacerbated by the other quasi-public benefits that the industry brings to local government, especially road clearing.

136. Local government would seem to have a particularly high stake in the permanence of regional economic activity. However, geographically unstable forestry generally implies a progression of farming and ranching activity. Hence, given the time horizon of most local politicians, such forestry is viewed as a good thing. A 20-30 year boom while the nutrients of the virgin ecosystem are mined is preferred to a more permanent, but reduced rate of economic development.

137. This lack of incentive for enforcement probably goes far to explain the current manifest lack of enthusiasm for taxing and regulating the logging industry. Even in areas where logging is technically allowed, government monitoring of lumber activities is notably lax. In principal, loggers are taxed for the wood they remove and are issued receipts ("notas fiscais"). These receipts should be presented at fiscal checkpoints maintained by the government on major highways leaving the Amazon. It is common, however, for loggers to falsify these receipts or retain them for later use with different loads of lumber. Moreover, these fiscal checkpoints are usually poorly staffed and can be circumvented by using alternate routes, sometimes constructed by the lumbermen themselves. Additional laws designed to control the flow of timber or increase the value added within the Amazon have also had little impact. For example, a

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/47 Logging has been reported on the lands of the Nambiquara, Cinta Larga, Suruí, Gavião, Arara, Kayapó, Guajajara, and Tikuna. For more information see Greenbaum, "Plundering Timber on Brazilian Indian Reservations" in Cultural Survival Quarterly, 1989, Vol. 13 (1).

law prohibiting the export of whole logs simply means that export quality logs are now cut into three or four large pieces before they are exported./48

138. Despite greater concern for environmental issues--as expressed in the Nossa Natureza Program and the creation of IBAMA--only token resources has been devoted to enforcement of logging activities, and policy commitment continues to be relatively absent at the local level./49 In addition, state and federal responsibilities have not been clearly delineated. Although the first president of IBAMA (Fernando Mesquita) recently threatened to shut down numerous sawmill operators in Manaus if they failed to submit management plans for rebuilding degraded areas, and explain the source of their lumber, IBAMA still does not have the staff at the local level to process even those seeking to comply. During a recent mission to Brazil (12/89), it seemed that IBAMA is so understaffed in Pará that it can process only a fraction of the applications to clear land in that state.

139. In addition, there are numerous ways to circumvent greater regulation. For example, there is a recent requirement that a RIMA (environmental impact statement) be submitted for logging on areas over 100 hectares. However, registration with IBAMA as a rancher rather than a lumber operator means that this requirement applies only to clearings of over 1,000 hectares. Although lumber companies are currently required to obtain operating licenses ("guias madereiras"), they are rarely punished for failing to produce them on inspection.

140. Summary and Recommendations. Policy initiatives designed to restrict timber and lumber operations must recognize the lumbermen's economic incentives to adopt land-extensive techniques, and the local political authorities' lack of political incentives to control them.

141. The lumberman will only see more conservative techniques as profitable if the current availability of cheap land is ended. A first step is to auction timber rights on public lands. The retention of most timbersheds as public land in the Amazon is an indirect subsidy to the lumber industry, in part because it frees the industry from having to pay for land acquisition.

142. Policy to auction timber rights on lands would have to be established at the national level, however. And even with national-level legislation, states and municipalities have strong short-run incentives to encourage local lumber activity.

143. The federal government needs a well-defined forest access policy. Road access is fundamental to the economics of logging and lumber production.

/48 Up to 10% of total international export shipments can be 3 inches or larger. The superior tribunal has ruled the embargo on interstate export of whole logs unconstitutional.

/49 In 1986, for example, Rankin reported that in Amazonas State, only 8 to 10 park guards were responsible for all of the parks, reserves, and forestry operation, which at that time amounted to about 1,600,000 km^2.

This in turn determines the value of land at auction, and the intensity of land use.

144. Local governments currently face tax/regulatory competition, which could be eliminated through the introduction of uniform policies. This suggests a strong role for the Federal Government.

145. Give local jurisdictions a piece of the action in regulation through fine-sharing or other incentives. Local gains from enforcement must be made greater than gains from non-enforcement.

Small Farmers

146. The poorest of Amazonian soils and growing conditions has been recognized only over the last decade, following the disappointing results of public and private colonization schemes during the 1970s and 1980s. High rates of turnover, abandonment, and land concentration by ranchers have been the rule rather than the exception. Marketing, credit, and agricultural services (extension) have been either unavailable or available only to a select few.

147. This section will first, briefly review the economic incentives for migration to the Amazon. Second, it will review the history of colonization projects in the Amazon, including various land tenure issues. Finally, it will discuss various issues involved in encouraging small farmers to adopt geographically stable techniques. This section is based on Annex 3.

148. The Incentives to Migrate. Farmers migrating to the Amazon came from two quite different groups: generally poor and landless farmers from the drought-prone northeast, and relatively better-off small farmers from the south (see Annex III). Farmers from the northeast have moved under the stress of drought and poverty. As discussed in Chapter I, those from the south have been more influenced by the rising value of land in the south relative to the north./50

149. Along with these factors, both public and private settlement schemes actively pushed migrants into Amazônia. Many projects were initiated with much fanfare, which often included TV and radio spots as well as printed brochures extolling the advantages of farming in Amazônia and downplaying or obscuring the

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/50 In a description and analyses of the various types of migrants coming to the Amazon, Anna Luiza Ozório de Almeida (1987, p. 9) asserts that the apparent superiority of the southerners in establishing themselves as colonists was largely an illusion, stemming from their relatively high level of initial capitalization and consumption. She claims that the rate of capital accumulation (from a much higher base) of southerners in colonization projects has been relatively low, and that in fact it was inferior to that of northerners and "caboclos." This may be a classic case of use of inappropriate technology. "Modern" techniques that were appropriate given the factor prices of the south were inferior to more traditional techniques when faced with the different relative prices of the Amazon.

region's risks (including poor soils and rampant malaria).[51] Many projects also began by providing generous terms and multiple services to first arrivals, which were later eliminated as the system grew strained. Once initiated, however, migrant flows have proved difficult to reverse even through official campaigns. Nevertheless, as southern migrants gradually become aware of the many problems of frontier life, and as national economic problems deepened, the volume of migrants arriving at many frontier destinations has declined (Annex I, Martine 1981, Sawyer 1984).

150. Agricultural settlement and titling efforts in the Amazon have succeeded in providing titles for many small and landless farmers, though many would argue that a much larger number remain unattended. Nevertheless, unequal INCRA land allocation and ineffective titling procedures combined with incentive programs for ranching (SUDAM) have encouraged land concentration and the expulsions of peasant farmers (Mougeot 1985). In Pará, for example, landholdings of 1,000 hectares and larger account for 0.7% of landowners but occupy 51% of the agricultural land (Hall 1987).

151. Amazon Agricultural Settlement Programs. Since the mid-1960s, the Brazilian government has launched several large-scale efforts to promote agricultural settlement in the Amazon. These include the Transamazon Colonization effort in eastern Amazônia, the Private Colonization initiative (northern Mato Grosso and south central Pará), and the semi-directed settlement efforts in Rondônia. Each of these projects has been associated with broader policy initiatives (PIN, POLONOROESTE, POLOAMAZONAS, Grande Carajás Program) that sought to develop the region and integrate it with the rest of the nation. These are discussed in detail in Annex 3.

152. The National Plan for Agrarian Reform. The National Plan for Agrarian Reform (PNRA), announced in October 1985, promised to redistribute underutilized public and private lands to landless farmers from areas where land conflict was especially acute. As such, it represented the new civilian government's response to the growing problems of land conflicts. The program planned to resettle 1.4 million families nationally and 630,000 in Amazônia between 1985 and 1989. Unfortunately, the effort suffered a number of revisions that weakened its original scope, as regional land reform plans were discussed

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/51 Frontier health conditions and the high cost of health care have presented a major economic constraint for migrants. Wilson (1985) notes that malaria had a savage impact on settlers in Rondônia in general. Transmission is aggravated by low income and internal migration to the extent that in certain cases it is both a cause and effect of small farmers' failure to establish stable farming operations (Vosti 1987). Butler (1985) notes that farmers located close to mining areas, which are heavy breeders of malaria, run special risks. Although malaria control remains a high priority in planning, malaria continues to spread, fostered by land clearing and road construction. At the Machadinho rural colonization program (Sawyer 1987; Vosti 1987), the average adult suffers three bouts of malaria annually. In 1988, there were 560,000 cases of malaria reported, yet Sawyer (personal communication) feels that because of under-reporting, there may have been as many as one million cases in 1988.

and finally approved by the federal government in May 1986. Of the 10 million hectares that were to be redistributed by 1989, Ministry for Agrarian Reform and Development (MIRAD) figures (cited by Hall 1989) report that, as of February 1988, only 11,000 families (4% of the original national target) had been resettled, and of that number only 836 families were in Amazônia. By the end of 1988, official resettlement targets had been revised downward by 70%, primarily as a result of lobbying by the UDR and other pressure groups of large landowners and ranchers./52

153. The degree and intensity of frontier land conflicts is closely related to the lack of stability of small farmer agriculture in frontier areas. Independent human rights groups in Brazil report that more than 1,000 Brazilians have died in land conflicts since 1980. The lack of law enforcement or clearly defined land titles have made the northern frontier region of Brazil (Pará, Amazonas, Roraima, Acre, Rondônia, Amapá) the most contentious region of Brazil with 141 registered land conflicts and 48 deaths since 1989 (Comissão Pastoral da Terra 3/89 figures)./53

154. Agricultural Production in Amazônia. All agricultural settlers in the Amazon confront similar problems as they adjust to the new physical, social, and economic environment. These problems include poor soils, new crops, unfamiliar climate, new pests, a variety of health problems (malaria, in particular), poor infrastructure and technical support, lack of basic services, new agencies to deal with, different market arrangements, and new social groups (Indians and gold miners). This section summarizes the important issues relating to agricultural production and the establishment of productive agricultural settlements in Amazônia.

155. Many small farmers in the Amazon practice what has been described as the peasant pioneer cycle: (i) clearing and burning the forest; (ii) planting food crops for 2 to 3 years until natural soil fertility declines; (iii) converting to pasture; and (iv) selling (to cattle ranchers) or abandoning the plot. The move to pasture formation may be accelerated by the relative failure of stable crop production.

156. Annual food crops (rice, corn, beans, manioc) are planted primarily by small farmers. Of the 17 million hectares of land cultivated in 1985, almost

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/52 A major victory from the landowners' perspective was the Decree-Law (No.2363) of October 1987 which declared ineligible for expropriation any property "effectively exploited" by the owner, as well as all farms below a certain size (1,500 hectares in Amazonia). Other concessions included limiting expropriation to only 75% of the property and stipulating that the Agrarian Debt Titles could be used as a liquid asset to buy other land and goods. Unfortunately the PNRA, with its requirement that owners show that their lands are productive, may have made matters worse by speeding up the expulsion of squatters from land and the conversion of forest to pasture.

/53 The death in December 1988 of Rubber Tappers Union leader Chico Mendes in Acre helped draw world attention to the struggle of tappers to secure user rights in the advance of extensive cattle ranching operations.

65% was in these basic food crops. Critics of annual crops (viz proponents of perennial crops) argue that they generally exhaust the nutrient-poor Amazon soil rapidly. In addition, these crops (especially rice and beans) are susceptible to the numerous weed and insect pests found in the Amazon. Erosion is also accelerated since these crops offer scant ground cover from heavy rains. Under these conditions, yields decline rapidly after the second or third year.

157. Over the last decade, government extension agents have actively promoted perennial crops as the best agricultural alternative for the region. The agents argue that these crops are generally better adapted to the region and therefore less susceptible to pest problems, maintain yields over a longer period of time, often are less perishable, and do not promote the same degree of erosion and soil exhaustion.

158. Although it is feasible to grow perennial crops, it is likely to prove difficult to grow them profitably in the Amazon. Price prospects are poor for coffee, natural rubber, and cocoa and international trade cartels struggle continuously to control chronic overproduction. As a consequence, as of 1987, perennial crops (including coffee, rubber, bananas, cocoa, oil palm, and black pepper) accounted for only a small fraction (452,100 hectares) of the 17 million hectares under cultivation (1985 Census).

159. From the small farmer's perspective, annual crops are preferred over perennial for the following reasons. These reasons are tied closely to the uncertainty over future land tenure conditions felt by the typical small farmer:

(a) you can get "in" and "out" of the crop in a short period of time;

(b) you can eat the crop even if you can't sell it;

(c) little investment is required; and

(d) you can realize a return in one season.

160. Perenniais, on the other hand, take an average of 3 years to establish (coffee, cacao, black pepper), with some crops like rubber taking up to 7 years to reach peak production.

161. Credit and technical services for all crops have been mixed, especially during periods of economic crisis. Often financing has not been available for the timely application of chemical and labor inputs needed to generate the highest yields. This is especially true when prices fall, leaving farmers with even less incentive to invest in a crop's proper maintenance. For example, Wilson (1985) reports that between 1983 and 1984, many coffee farmers in Rondônia felt that they could simply not afford the recommended technical packages, given the price of the product.

162. Marketing of Food Crops. Although little hard data are available on the ultimate destination of food crops produced in frontier Amazônia, evidence suggests that most are consumed by the farmers themselves or sold locally. Many frontier areas grow rapidly in their initial phase as a result of gold, lumber, and land rushes. Often farmers are not able to meet even local demands for

staples (except for manioc with its high sustained yields) during the initial settlement period (first 2-3 years).

163. During these early years, demands for staples (rice, corn, beans) are often met in part by food trucked in from states outside the region. As local farmers start to produce more food, they gain a greater share of the local market. Nevertheless, they still face stiff competition from supply networks established between local retailers and producers in other areas to the south.

164. Often, principal highways leading into the region are in better condition than local roads. Planned settlement efforts generally place greater emphasis on maintaining main trunk roads, neglecting feeder roads which often become impassable during the rains (Wilson 1985; Moran 1981; Nelson 1973).

165. Grain storage systems are also often not adequate to meet farmer's needs. The combination of inadequate storage services and the lack of reliable methods of getting crops off the farm and to the market on a regular basis have resulted in significant losses for farmers.

166. Marketing Perennial Crops. Different perennial crops are marketed in different ways. Some crops, like bananas, can be sold locally. But many, like rubber, guarana, and cocoa, are typically marketed through government agencies (CEPLAC for cocoa, SUDHEVEA for rubber, etc.) whose services have been considerably reduced in recent years. Furthermore, export crops, such as cacao and rubber, may suffer dramatic declines on the international market which sometimes provoke changes in the structure of national support for these crops.

167. In Amazônia, transportation costs have accounted for a significant portion of a product's market cost. Year-round transportation networks (by river or road) between farmer and market are a key to the development and growth of farming areas. The lack of such linkages and their proper maintenance has been identified as a major problem for farmers throughout Amazônia (Wilson 1985; Moran 1975; Tavares 1972).

168. Government Programs and Policies. Governments have supported small farmers principally through credit, extension, marketing and price support services, and fiscal incentives. These are reviewed briefly below.

169. Credit programs support the cultivation of rice, corn, and beans, but have done little to promote these crops. Many small farmers are wary of this type of credit because there have been past problems associated with inflation indexing, and incentives have led to overproduction and bankruptcy. The delivery of credit has also been criticized for: (i) being so complicated and time-consuming that farmers end up losing weeks of valuable work time in government and bank offices trying to obtain credit; and (ii) credit lines often run short of funds before the end of the crop year. Ironically, larger farmers, who are generally able to obtain credit more easily than their smaller counterparts, have tended to use credit for other (nonagricultural) purposes that they see as better investments.

170. There has been very little farm-level research done in the Amazon. This is due largely to budgetary constraints and the difficulty of encouraging scientists to work in the field and in the Amazon.

The lack of interest in EMBRAPA-promoted fertilization practices in Machadinho reflects the relative abundance of land. Out of an average lot size of 47 hectares the average area cultivated was 6 hectares, with 37 hectares still in virgin forest. As long as new land can be burned, providing a high nutrient, relatively pest free environment, it makes little sense to invest in fertilizers to maintain the fertility of tiring soils. The fact that this practice is not biologically "sustainable" can be faced later, either through bush fallow, fertilization, or most likely, selling out to ranchers. These agricultural practices are reflected in the inventory of equipment owned by the settlers: only two pieces of agricultural equipment were owned by more than 15% of the farmers--89% of the farmers owned a hand planter and 44% owned a chain saw.

Box II-2: Appropriate Technology

171. Alternative input packages have been tested successfully under field conditions elsewhere, and are reportedly under development by EMBRAPA/Manaus among producers on the outskirts of Manaus. The fertility requirements for continuous crop production in a Ultisol in Yurimaguas (Peru) have been investigated since 1972 (largely under the auspices of North Carolina State University) under peasant farming conditions. According to Cochrane and Sanchez (1982), packages have been developed which provide very substantially higher incomes for intensive, continuous cropping systems than are available from alternatives./54 The fertilizer requirements are high, however, and the severity and complexity of nutrient deficiencies require frequent soil testing (every six months) and correction of micronutrient deficiencies. This suggests that such systems require readily available credit, fertilizer, systems for soil analyses, and a reliable marketing system. Lower-cost systems were agronomically successful using green manuring techniques (generally with kudzu), but labor costs were excessive and careful attention to nutrient deficiencies was still necessary.

172. Lack of appropriate and consistent technical assistance from the state-level extension agencies (EMBRATER/EMATER) has also been identified as a problem in most agricultural settlement areas. These agencies are practically non-existent in many parts of the Amazon. This is partly due to a severe funding crisis that has left many extension offices with reduced personnel and operating budgets. Where they exist, extension agents often do not have the information most important to newly arrived settlers, such as accurate information on soils and rainfall patterns. Agencies promoting specific cash crops such as CEPLAC (the government cacao agency) seem to provide somewhat better services.

173. Since 1987, after budgetary responsibilities developed to the states, extension services in the Amazon have been in severe decline. Nearly 70% of the budget for extension services (EMATERS) in the Amazon is absorbed by salaries.

/54 Cate and Coutu (1977, reported in Sanchez and Cochrane, op. cit.) report that these systems yielded a net income on a small family farm (under seven hectares of continuous cropping) of $6,000. This compares to the annual average rural income of $750 in the project area and $1,500 for the top 25% of families in the "Barriadas" of Lima.

Farmers have, by and large, ignored extension service advice with respect to input packages. Whether that is principally due to inappropriate packages, lack of credit, or ignorance is not clear, although the most likely explanation is that they are inappropriate for the physical and economic environment. For example, according to a survey of colonists in the Machadinho settlement in Rondônia (Miranda 1987), there was insignificant use of soil analysis, liming, and fertilizing even though there was an EMBRAPA research station located in the project (which 35% of the settlers were aware of and 11% had visited).[55]

174. Government Roles in Marketing, Price Support and Transportation Subsidies. As mentioned above, the lack of local markets critically limits the growth of food crop production in Amazonian settlements. Efforts to penetrate markets to the south, on the other hand, compete with products that have lower transport and storage costs. Recent increases in food crop production in the rest of the country have also increasingly marginalized the more remote initiatives in the Amazon. These increases are primarily in areas closer to the major markets (Belém-Brasília, Mato Grosso, Mato Grosso do Sul, and in the internal frontiers of the traditional producer states), and recently along the river valleys in the northeast, following advances in irrigation.

175. As competition from other areas increased, the penalty imposed by distance grew increasingly important. This was exacerbated by an increase in real freight costs of 50% in 1989. Estimates in Rondônia (Lopes, 1990) suggest that in 1989 freight costs for maize (to the nearest major southern market) as a percent of wholesale price were 20%, 16%, and 44% for Goiás, Paraná, and Rondônia, respectively (this is equivalent to 38%, 27%, and 112% of the respective producer prices). For rice (beneficiado) freight costs were 16% and 35% of the wholesale price for Goiás and Rondônia, respectively.

176. This tremendous locational disadvantage has been neutralized historically in certain areas of high priority by the CFP's purchases under the minimum price program. Although CFP has never had the resources to guarantee the minimum price everywhere, it has historically made a special effort in high-visibility colonization areas, such as the PDRIs of Mato Grosso and Rondônia. In effect, the cost of locational disadvantage was passed to the taxpayer.

177. The fragility of this system became evident in 1989. The lack of resources caused the CFP to scale back its participation dramatically. In the PDRI of Rondônia, CFP purchases of rice, beans, and maize were slashed from 107,000 tons in 1988 to 18,000 tons in 1989. CFP purchases in the PDRI of Mato Grosso went from 400,000 tons to 30,000 tons.

178. Without CFP purchases, rice and maize found virtually no market in Rondônia in 1989. Its lower transport costs relative to market value meant that beans still found a good market to the south, even without government intervention.

179. The uniform price system for fuels is an additional wedge between economic viability and private profitability. According to IPEA (reference),

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/55 There was limited use of graded seeds and soil conservation practices, however (12-15% of the farmers), depending on the crop.

eliminating this subsidy would lead the weighted average of the price of diesel fuel to increase by about 35% in Rondônia, and nearly 50% in northern Mato Grosso. This would increase the cost of rice and maize production by 5% in Rondônia and 6-7% in the north of Mato Grosso (Rondonópolis), with similar increases in the costs of freight.

180. Discussion. Poor farmers who have failed to gain access to farmland in Amazônia remain a major problem. The difficulty in obtaining title to squatter's land is certainly one part of the problem. More efficient titling would help to promote more stable farming communities throughout Amazônia, since title is often needed to obtain credit and other services. Titling should be delinked from any requirement related to "productive use," however. Such "anti-speculation" legislation generally does not succeed in creating new economic opportunities; rather it tends to force "premature" (uneconomic) activity as a cost of establishing title./56

181. Although secure land titles would help to stabilize the frontier through removing current disincentives to invest in location-specific activity, security of title alone cannot overcome the lack of profitable farming techniques that do not rely on constantly opening new land for their profitability. Stability will be attained only when a farmer using biologically sound and geographically stable techniques achieves a better standard of living than he can gain through the "peasant pioneer cycle," all other things being equal. As long as nutrient mining can offer a better life than settled agriculture, it will continue to be the prevailing practice.

Placer Miners (Garimpeiros)

182. Since the start of the Brazilian Amazon gold rush in 1980, garimpagem, or placer mining, has been an increasingly important part of regional mining. Although placer mining existed in areas such as the Tapajós basin (western Pará) as early as the 1950s, rising gold prices, a worsening economy, an influx of migrants, and the discovery of a very dense concentration of gold in a vein in Serra Pelada (southern Pará) all encouraged the gold rush that began in 1980. By 1982, over 50,000 garimpeiros were mining in the Serra Pelada and Cumarú mines in the Carajás area of southern Pará (Schmink 1985).

183. Value Produced. Table II-11 compares informal, garimpo production with that carried out by registered mining companies. The table also describes both the official and real production of gold over most of the last decade (1980-1988). Real production figures represent official production (that reported to the government) plus the estimated amount sold illegally. The DNPM (Departamento Nacional de Produção Mineral) estimates that real gold production is between 3 and 5 times the official figures. Between 1980 and 1988, the Legal Amazon produced (by official estimates) $13 billion in gold. This represents over 80% of Brazil's gold production for that period. Garimpos were responsible for most of that production.

/56 Anderson (1989) refers to "premature economic activity" under similar circumstances in the settling of the American west.

184. The DNPM estimates that garimpos cover about 170,000 km^2 (roughly 4%) of the approximately 5 million km^2 Legal Amazon. Within the Legal Amazon, Pará State has the largest area dedicated to garimpo activity, approximately 100,000 km^2 (according to the DNPM). ? also shows the relative importance of garimpo activity in different Legal Amazon states. Map 1 (Annex) illustrates the major garimpo areas in the Legal Amazon, as well as their proximity to urban areas, areas of settlement, and areas with a high incidence of malaria.

Table II-11: GOLD PRODUCTION FOR THE BRAZILIAN AMAZON, 1980-88
(In Tons)

	Producer /a	Official	Actual /b	Total
Pará	G	145.1	570	715.1
Mato Grosso	G	38.4	180	222.5
	I	4.1	--	4.1
Rondônia	G	18.3	75	93.3
Amapá	G	2.9	18	26.4
	I	5.5	--	5.5
Roraima	G	8.7	40	48.7
Maranhão	G	1.5	6	7.5
Others	G	20	10	12.0

Source: DNPM.

/a G = garimpo production; I = Mining company production.
/b Estimated unreported production.

185. Estimates of the number of people directly involved in garimpo activity in the Legal Amazon vary between 650,000 (DNPM) and 800,000 (DNEHSA). These numbers include workers providing general services to the garimpo (from transportation to sales of basic goods, entertainment, and prostitution). There are probably 300,000-400,000 actual miners at any one time, with many part-time miners rotating in and out of the garimpo.

186. A recent study of some of the major garimpos carried out by the Ministry of Health as part of the Nossa Natureza Program (DNEHSA 1989) provides the following figures on garimpo populations: (i) in Pará, the Tapajós River basin (400,000) and Serra Pelada/Cumarú complex (130,000); (ii) in Mato Grosso, the municipalities of Alta Floresta and Peixoto de Azevedo (170,000); and (iii) Rondônia, in particular, the Madeira River (60,000). These, along with the almost 100,000 miners in Roraima, are the major placer mining complexes in Amazônia.

187. The mining camps themselves typically contain anywhere from several hundred to several thousand miners each, except very rich and concentrated deposits such as the main Serra Pelada mine with over 50,000 at its peak. In 1985, SUCAM (Superintendency for Public Health Campaigns) identified 932 different mining camps in operation in Pará, most associated with the two large complexes of Tapajós and Cumarú/Serra Pelada.

188. Placer Mining (garimpo) Technology. Garimpo technology varies widely, depending on accessibility and richness of the site. At the most primitive level, it consists of manual panning and rustic wooden sluice boxes. Where access is better and the deposits are richer it often consists of mechanical pumps that use water to suck up gold bearing alluvial soil, and others that propel jets of pressurized streams of water at the sides of pits to excavate gravel and dirt rapidly. Small motorized crushers are used to pulverize rock. In a final step, gold-bearing sediment is washed, allowing the heavier gold to settle in various steps in a slide-like trough while lighter sediment wash past.

189. In most areas, alluvial gold dust is excavated near small stream beds. The major exception is the dredging of major rivers, like the Madeira (Rondônia), where underwater divers use hoses to comb the streambeds. The operations on the Madeira use perhaps 6,000 large motorized rafts, indicating a significantly higher capital investment than the more standard operations described above.

190. Despite the increasing mechanization of garimpo mining, technology is still limited. Many garimpo mines have a very short life span (often 5 to 7 years) precisely because the technology used can exploit only relatively shallow deposits (Cleary 1987).

191. Even very rich deposits have relatively limited lifespans. In the major open pit mine of Serra Pelada, for example, there are now only about 3,000 garimpeiros working full time, compared with 50,000 at its peak in 1983. Work is more dangerous now as there are frequent cave-ins in this 130-meter hole, which used to be the world's largest placer mine. Over its 10-year history, Serra Pelada produced about 40 tons of gold--14 tons in 1983 alone. With current garimpeiro technology, Serra Pelada barely produced one ton in 1989. The area will most probably be leased to a Japanese-affiliated mining concern (possibly Mitsubishi) which will rework the tailings, and may initiate new excavations which could yield 10-30 tons of gold (Pinto, 1990).

192. Linkages to Local Economy Although it undoubtedly has important effects on the local economy in certain cases, such as Rondônia, there is very little good information on this garimpo activity. Despite the lack of hard data, the following potential impacts can be identified from an economy which involves 800,000 people and produced over $13 billion in revenues in less than a decade.

193. The towns and municipal seats that are the supply centers for many of the mining operations certainly benefit from the mining activity. Although mining camps go from boom to bust as gold deposits run dry, larger urban centers provide services to mining operations as long as the region itself remains active. These services include sales of fuel, food, equipment, telephone and post services, legal and judicial services, and nightlife. These larger centers survive and may even prosper after the gold rush declines if sufficient local investments have been made to provide services to other evolving economic activities (lumber, agriculture, ranching).

194. In Porto Velho, Rondônia, the local construction industry has experienced a boom with the construction of the hundreds of rafts involved in mining activities on the Madeira River. In southern Pará, the population of Marabá is estimated to have increased from 60,000 in 1980 to 133,000 in 1985 and some 250,000 today. Marabá, in Pará, has been influenced both by Carajás and Serra Pelada (see Map 1 for proximity of garimpos to urban centers).

195. In general, the better the infrastructural access and the closer the garimpos are to the service center towns, the more money is likely to be spent in those areas. Garimpos located in remote parts of the Amazon, like Roraima, are the least likely to leave any material benefits in the state or municipality. Profits will go to the nearest large city, including into the overnight market investment.

196. Direct and Indirect Effects on Agriculture. The garimpos have a mixed effect on agriculture in Amazônia that depends largely on the relative effect on input and output prices. Overall, farmers located near the regional service centers will prosper as these areas themselves prosper, largely because the effect on output prices will more than balance the effect on inputs. Farmers located near a garimpo area but not near one of the regional service centers, are more likely to suffer from the negative aspects of the garimpo (high costs of farming, malaria, lack of access to banks and other services etc).

197. On the input side, garimpagem draws labor away from other productive activities, including farming and ranching. The effect of the garimpo economy on local wage costs is often blamed for crippling other economic activities because it makes all goods and services considerably more expensive. Thus a mining boom can provide a boost to an area that is suffering from unemployment and the general malaise of a national economic crisis, but it may severely disrupt the establishment of other economic activities.

198. The effect of garimpagem on output markets is generally not likely to compensate for its effect on input markets. Although some farmers and ranchers manage to sell to garimpeiros when productive farming operations are located on the major roads leading to garimpos, many garimpo areas, especially those a long way from agricultural settlements, obtain their food supplies directly from major urban centers or even from areas outside of the Amazon. This is especially true of Pista economies where convenience of transportation is at a premium.

199. Environmental Problems. Garimpagem causes a number of environmental problems. These include those associated with the changing of stream courses, deforestation, siltation, and the pollution of rivers with metallic mercury, motor oil, and human waste. For example, the Tapajós river, whose natural color is green, has now turned yellow as a result of suspended materials. This in turn reduces the sunlight needed for organic life in the rivers. The huge amounts of soil needed to move and wash the pay dirt are largely emptied into the river. Detergents are used by miners to clean oil from the water, as oil reduces the amalgamating action of the mercury on gold. Both oil and detergents have been observed far downstream.

200. Despite the known health problems associated with mercury contamination, mercury's use is pervasive, principally because metallic mercury is currently viewed by most garimpeiros as the most efficient way to concentrate alluvial gold dust. According to DNPM estimates, two grams of mercury are used for each gram of gold extracted. Rogério da Silva, former environment coordinator for DNPM (Belém) calculates that over 330 tons of mercury have been used in the Tapajós River basin alone, and between 1,800 and 2,000 tons of mercury have been dispersed throughout the Amazon since the gold rush started in 1980.

201. There are at least three groups at risk from mercury contamination: the miners who concentrate gold dust and then burn the gold-mercury amalgam; the gold buyers who further burn the amalgam to remove other impurities; and the populations who live down river and within the area of gold production who consume fish as one of their major sources of protein.

202. In 1989, the DNPM collected 700 samples (550 in Pará, especially the Tapajós) of hair, blood, sediment, water, and fish from garimpo areas throughout the Amazon. All indicated some evidence of mercury contamination (da Silva 1989). CVRD contractors investigating garimpeiro sites within the greater Carajás area found that although fish, water, and fluvial sediment contained mercury above the limits established by the Ministry of Health and the Conselho Nacional de Meio Ambiente, none of the 29 humans tested showed evidence of mercury poisoning.

203. Although no hard data exists on the amount of deforestation directly associated with garimpos (as compared to that caused by ranching or agriculture), the construction of airstrips, roads, and mining camps is certainly the main cause of deforestation in certain limited areas.

204. Malaria and other General Health Problems of the Garimpo. In addition, garimpo areas are sites of malaria, sexually transmitted diseases, hepatitis, and a variety of human ailments associated with uncontrolled boom towns. Due to both the nomadic garimpeiro lifestyle and the fact that a garimpo can "play out" at any time, very little public or private investments are made in basic living conditions in mining areas. According to Cleary (1987), the entire population of most garimpos, regardless of income, lives in precarious conditions including poor housing and sanitation, poor drainage, contaminated water supplies, and scarce basic health services.

205. Garimpos facilitate the transmission of malaria for the following reasons: (i) close living quarters, usually with no walls or screens to reduce feeding mosquitos; (ii) forest clearings with many poorly drained areas provide ample breeding ground for mosquitoes; (iii) garimpeiros carry malaria, both from one camp to another and to areas beyond the garimpo; (iv) common self-medication with anti-malarial drugs contributes to greater parasite-drug resistance; and (v) the many garimpos are hard to reach, which makes sustained DDT spraying by SUCAM (the federal agency charged with malaria control) almost impossible.

206. A recent PHRHN report (Wilson and Alicbusan 1990) states that even though garimpeiros are a relatively small group in a regional population of 17 million, they have had a major impact on the incidence of malaria. In Pará, miners were responsible for 65% (67,000 cases) of the malaria cases reported during 1986. In Mato Grosso, mining operations accounted for over 50% of the malaria cases reported from 1985 to 1987. Fifty percent of all the malaria in Amapá in 1986 came from just two garimpo areas. Finally, in Rondônia, malaria in two municipalities was closely linked to the 100,000 garimpeiros working the Madeira river. Furthermore, part-time miners are linked to the transmission of malaria outside of the Amazon. A Brazil-wide survey of 53,000 cases of malaria in 1985 revealed that 9,000 cases originated with garimpos in São Felix do Xingú municipality in southern Pará, who brought it to 381 different municipalities in 18 different states. Another 2,000 malaria cases from the Colider municipality in northern Mato Grosso were exported to 235 municipalities in 17 different states (Marques 1988, cited in Wilson and Alicbusan 1990).

207. Disruption of Native Populations. The discovery of gold on Indian land has meant problems for native groups throughout the Amazon. Current estimates indicate that the number of gold miners in Indian areas in Roraima

could be as high as 80,000 to 100,000. These miners extract approximately 30,000 kilos of gold a year.

208. There are approximately 35,000 Indians in Roraima. Although the approximately 9,000 Yanomami are the largest, best known, and least acculturated group, other Indian groups have also reported invasions by miners, most dramatically in the Surucucus Indian Reserve. A Brazilian human rights group, Action for Citizenship, claims that runways (pistas) built within the Reserve by the Brazilian Air Force as part of the Calha Norte Project have facilitated penetration of the area by miners.

209. Among the most serious problems for the Yanomami, who have had little prior contact with non-Indians, are diseases to which they have little resistance including malaria, TB, venereal disease, skin diseases, and oncocercose (an eye infection). According to FUNAI doctors, the death rate has risen in those villages closely associated with mining camps. Another problem is that the amount of available game, an important source of protein, seems to have declined since the miners have arrived, reducing some Indians to begging (Cultural Survival Quarterly 1989).

210. Over the course of 1989, as the invasion of miners intensified, the very agencies assigned to protect the Indians were often nowhere to be found. During its 1989 visit, Action for Citizenship reported that many FUNAI posts had been abandoned, supposedly for lack of funds. Apparently for much of 1989, there were only two FUNAI doctors in all Roraima to serve Indian needs. In addition, only one permanent judge and a federal police force of only 27 agents made removal of garimpeiros from Indian lands almost impossible. The fact that Yanomami lands have never been fully demarcated adds to the confusion. In February, 1990, gold miners were removed from Yanomami lands under federal court order but were later allowed to work new claims in the nearby Roraima National Forest./57 More recently, President Collor ordered the destruction of illegal airstrips used by miners inside the territory of the Yanomami and other groups (New York Times 3/26/90).

211. Some Indian groups, like the Kayapó in Pará, have reached an agreement with the miners so that they receive a percentage of the mining income (a royalty). This arrangement is similar to that worked out with some landowners where a royalty or indemnity is paid to the property owner, equal to 10% of the gold extracted.

212. In Pará, there are approximately 2,000 Kayapó divided among 5 villages and occupying an area of approximately 32,000 km^2. Two of the villages (Gorotire and Kikretun) receive about 13% of the gold sales. According to Veja Magazine (11/15/89), the Gorotire village earned NCZ 550,000 during the month of October, 1989. Although many Kayapó would undoubtedly prefer a return to the days before miners encroached on their land, at least they are able to reap some of the wealth being extracted from their reserve. According to some Indian leaders, these royalties simply allow them to treat some of the problems

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/57 Indian rights' groups claim that these forest lands ceded to prospectors actually form part of the Yanomami reserve as originally created in 1985 (Brazil Watch Feb. 12-26, 1990).

(widespread malaria, for example) that were caused by the garimpeiros in the first place.

213. In the Tapajós region, the Mundurucú Indians have been affected by the garimpeiros in the region since the early 1970s (see Burkhalter 1982). Some Mundurucu began panning for gold within their reserve as a source of income. Apparently most miners have stayed out of the reserve because it does not contain the richer deposits in the area.

214. The degree of acculturation, the relative wealth of deposits inside Indian areas, and the rapidity with which miners invade the area all seem to influence the way in which indigenous groups will deal with garimpeiros. In most cases, without clear government support for Indian actions to deal with garimpeiros, uncontrolled mining will continue to levy a heavy toll on native peoples.

215. Possible New Policy Measures. Since the beginning of the gold rush in 1980, various government agencies have expressed interested in controlling garimpo activity for different reasons, which include: (i) a desire to limit environmental damage and mercury contamination; (ii) a desire to improve the health conditions of the garimpeiros and to control the spread of malaria; and (iii) a desire to control the sale of gold and capture some revenue through taxes.

216. Government efforts to deal with garimpo activity have generally failed because they lacked both human and financial resources and a clear plan of action. The relative remoteness of many garimpos and the attendant costs of maintaining a permanent presence would make any plan difficult to implement.

217. The lack of agreement on a plan of action by federal, state, and municipal agencies seems to have prevented the government from taking even the most elementary steps toward controlling the garimpos. For example, the government has made little effort to regulate the use of illegal landing strips and the planes that use them. In Roraima, there are only 3 registered air strips, and an estimated 70 illegal ones. With over 300 takeoffs a day, the Boa Vista airport is one of the busiest in Brazil. Most of the garimpo pilots file fake flight plans with the Civil Aviation Authorities.

218. Municipal and state governments where mining plays a central role are likely to be interested in getting their share of revenue from mining, be this from taxation or from the other commercial activities associated with the mining economy. If federal government programs threaten an important source of state or municipal income, local officials are likely to block implementation efforts. This is in fact what has happened to efforts made in Roraima to remove garimpeiros completely from Indian lands. The Yanomami situation, which involves international borders, is complicated further because of the military's concern to promote the occupation of the frontier strip along Brazil's northern borders, through the Calha Norte Project.

219. Limiting Environmental Damage. The key to any government environmental control program is education, increased health services, and the provision of alternatives to the current process of gold amalgamation. The alternatives offered by the government must be affordable, recognized by the

garimpeiros as healthier, and they must provide similar profit margins in gold sales.

220. Many current papers on mercury pollution are primarily concerned about its negative impacts on the environment, rather than the human populations most immediately affected--the garimpeiros. More often than not, the garimpeiros are seen as the perpetrators of ecological disaster rather than as its victims as well. However, only through a direct and sincere appeal to this population is there any hope of controlling the situation.

221. Despite the serious health problems in the garimpo, there is no clear policy on the governments' responsibility in these areas. In 1989, the government tried to develop a health plan for garimpo areas and a commission was formed to devise such a plan, but none has yet been implemented (DHENSA, cited in Wilson and Alicbusan 1990).

C. Geographically Stable Activities

Extractivism[/58]

222. Since the early period of contact with Europeans, extracting natural products from the forest has been the traditional base of the Amazon economy. Many observers also promote it as the alternative to current land use changes. Both economic forces and the withdrawal of active government support are however leading to a decline of the natural sector products.

223. Background. The social and economic history of the region, from contact until the era of modern development schemes, centers on the exploitation of a few valuable export products (such as rubber and brazil nuts) under near-feudal conditions. Labor was scarce, so first Indians and later poor northeasterners were recruited to gather these forest products. Supplies were advanced to gatherers by river traders and landowners controlling huge gathering concessions, and these supplies (coupled with physical coercion) were used to keep laborers in a form of debt peonage. Only minimal capital investments were made.

224. When world markets declined, as they did when rubber seeds were smuggled out of Brazil to allow the development of British-controlled plantations in southeast Asia, boom economies went bust. Rural rubber tappers, many unable to return home, joined the ranks of river-dwelling peasant populations who survived through forest gathering, hunting, and fishing. The gathering of a wide variety of forest products became an essential part of survival for many forest-dwelling people.

225. People classified as extractivists fall into two general categories: those who depend on the sale of their extractive products as their primary source of income, and those who gather forest products for subsistence and may occasionally sell forest products when cash is needed. The first group is

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/58 This topic is currently the subject of a large debate in the Brazilian scientific community. For more detail, consult the proceedings of the last congresses of the Sociedade Brasileira de Economia e Sociologia Rural (SOBER).

occasionally sell forest products when cash is needed. The first group is primarily made up of rubber tappers and brazil nut gatherers, while the second primarily consists of tribal peoples. In addition, some frontier settlers, such as small farmers, may occasionally exploit some of the forest products on their lands to supplement their incomes.

226. According to FUNAI figures, the indigenous population of the Legal Amazon numbered about 129,292 in 1989, and there were around 90,000 rubber tappers and other extractors. Although tappers and nut gatherers can be found throughout the Amazon, the largest and best organized groups today are in Acre and Rondônia.

227. In 1980, Brazilian census data (IBGE) indicated that of the 4.4 million km^2 in the north region (Amazonian States) and Mato Grosso, only about 100,000 km^2 were dedicated to extraction, while 600,000 km^2 were dedicated to ranching and farming.

228. Rubber and brazil nuts accounted for 90% of the $45 million of extractive products sold in the north in 1980. Agricultural census data indicate that over 27 different products (latex, fiber, nuts, and fruits) were collected by extractivists with a value of over $44,213,000. Rubber alone accounted for over 65% of the total value of production.

229. Viability. The future of extractivism will depend on its ability to provide a better life for extractivists than they can obtain in alternative employment. Recent trends suggest that without heavy government subsidies, extractivism is not likely to compete successfully with other activities. The future of natural rubber extraction in Amazônia is limited by several factors: (i) the expansion of cultivation in other parts of Brazil and worldwide; (ii) the production of cheaper petroleum-based synthetics; and (iii) the uncertain future of governmental assistance to rubber.

230. As shown in Table II-12, extractivism has not competed well with other forms of agriculture in the Amazon. At the of the nineteenth century (1910), extractive activities accounted for over 90% of the agricultural GDP. By 1980 this share had fallen to only 23.35%.

231. Many traditional rural extractive areas continue to experience population decline as gatherers move to regional towns. The town of Eirunepe in Amazonas state, for example, has grown from 8,000 to 30,000 over the last 5 years as tappers (seringueiros) leave rural isolation to seek a better life in town (Parfit 1989). This trend is evident throughout the region as the real returns from rubber tapping continue to decline.

232. In 1989, rubber prices in Brazil were approximately three times higher than the international price, as the government tried to protect the local rubber industry by taxing imported rubber and subsidizing local prices. Nevertheless, the Brazilian rubber industry, based on natural forest exploitation, cannot keep pace with the efficiency of plantation rubber, produced primarily in southeast Asia. Today, Brazil produces less than 1% of the world's natural rubber (Fearnside 1989).

233. The fact that successful rubber plantations are being established in Brazil outside the Amazon (São Paulo and Mato Grosso) adds further incentive for the government to eliminate the current rubber subsidy. Other forms of official support for extractivists (especially rubber tappers) have eroded in recent years. Largely as a result of budgetary cutbacks, SUDHEVEA (National Rubber Promotion Agency) was merged in 1989 with other agencies to form the Environment and Renewable Resources Institute (IBAMA). Rubber tappers are no longer provided rural services, including basic foods at controlled prices, medical and dental extension services, regular information of rubber prices and rubber processing technology, and other supports that were previously available under rubber promotion campaigns (PROBOR I, II, III). These campaigns attempted to ease the tappers' isolated existence, and keep them from leaving strategic production and frontier areas.

Table II-12: PERCENT OF FOREST EXTRACTION, CROP PRODUCTION, AND RANCHING IN THE AGRICULTURAL VALUE-ADDED OF THE NORTH, 1890/1980

Year	Forest Extraction	Agriculture	Cattle Raising
1890	70.28	15.09	14.63
1900	78.15	11.51	10.34
1910	90.62	4.39	4.99
1920	46.30	25.30	28.40
1939	35.22	37.13	27.65
1947	54.94	25.25	19.81
1948	44.90	28.57	25.53
1949	53.17	33.27	13.56
1950	48.88	28.70	22.42
1951	55.13	28.87	16.00
1952	48.84	27.88	23.28
1953	52.96	33.77	13.27
1954	45.03	31.59	23.38
1955	44.64	31.53	23.84
1956	46.09	29.00	24.91
1957	50.85	26.48	22.67
1958	36.74	32.60	30.66
1959	39.38	33.26	27.36
1960	41.15	32.61	26.24
1961	33.16	30.32	36.52
1962	34.19	35.95	29.86
1963	33.95	38.95	27.10
1964	30.81	30.42	38.77
1965	28.76	37.14	34.10
1966	25.41	38.19	36.40
1967	22.37	35.05	42.58
1968	23.95	36.20	39.85
1969	22.61	36.98	40.41
1970	29.79	35.08	35.13
1971	25.81	36.87	37.32
1975	19.90	62.10	18.00
1980	23.35	53.23	23.42

Source: For the years 1890, 1900, 1910 and 1920 Santos (1980); for 1939 and 1947/1969 "Conjuntura Economica" 1971; 1970, 1971 and 1975 from SUDAM (1982). 1980 estimate is based on the 1980 Agricultural Census.

234. Economics of Extractivism. Several studies have compared the economics of geographically stable extraction with other options that require deforestation. In one of the most publicized studies, Peters, Gentry, and Mendelson (1989) catalogued a range of marketable fruit, latexes, and medicines from a section of Peruvian Amazon that over the long term could provide profits several times greater than logging or clearing the forest for pasture. Of the 275 tree species on the plot studied, 72 provided products that had market values in nearby Iquitos, Peru. Together, this could provide $322 per hectare per year. By discounting future earnings for each type of economic activity included in the analysis (extraction, ranching, logging), these researchers attempted to show that in this specific case, extraction (even after transportation and regeneration costs) could provide greater long-term returns than other more destructive activities.

235. Other studies have also tried to show that extractive activities can compete successfully with economic activities that involve deforestation. Hecht, Anderson, and May (1988) discuss the various uses of the babaçu oil palm. A

natural succession plant, which grows rapidly and well on degraded lands, the nut of this palm has commercial uses ranging from high grade cooking oil, to charcoal and animal feed. Thousands of peasants, primarily in Maranhão, currently depend on the collection and sale of this nut for their survival. Hecht and Schwartzman (1988) have also documented a number of economic reasons for creating extractive reserves.

236. Although there is a good deal of optimism about the potential for extractive economies, further research is needed since much of the work done so far is case-specific and may not apply equally to other parts of the Amazon. There are still significant questions about the limit of collection capacities and transportation costs, the ability of markets to absorb increased production, and means of expanding the production of exotic forest products.

237. Unfortunately, the great majority of Amazonian fruits have little or no market beyond Amazônia. According to Fearnside (1989), except for brazil nuts, the only economically significant food products are the palm fruit "açaí" (Euterpe spp.) with an estimated annual value of $594,000, and heart of palm (from a variety of palms) with an estimated value of $855,000. Together they account for less than 3% of the value of annual extraction (see Fearnside). Palm heart is canned for international export while "açaí" has a substantial local market in many Amazon communities.

238. Returns to Whom? Studies which demonstrate that returns per hectare are higher in extractive uses than other uses do not make the case for extractivism. A complete analysis would compare returns per productive unit, including land, labor, and capital valued at their opportunity cost. If it is necessary to calculate the returns to only one factor it should be that factor which is most constraining for additional production. Because land is the most abundant factor in the Amazon, land productivity (returns to land) is the least significant indicator of potential market competitiveness. This, of course, is demonstrated by the market, where forest extractivism has tended to vanish wherever capital and labor have reasonable alternatives.

239. Recent Government Policy. Recently, the Brazilian government has begun to show interest in establishing extractive reserves. Existing and proposed reserves for the Brazilian Amazon comprise about 20,000 km^2 (almost exclusively in Acre, Rondônia, and Amapá), with a total population of about 2,300 families (Fearnside 1989). This compares to slightly less than 100,000 km^2 (in 92,783 establishments) that, according to the census, were used for extractive purposes in the north region in 1980.

240. During his last days in office, former president Sarney designated over 10,000 km^2 in Amazônia, Acre, Rondônia, and Amapá as extractive reserves--one bearing the name of Chico Mendes, the assassinated leader of rubber tappers.

241. Current legislation in relation to extractive reserves, such as the decrees establishing individual reserves, is subject to short-term expiry. Unless measures are taken to extend their current legal status, some extractive reserves will cease to exist in the near future.

242. Extractive reserves technically belong to the government through IBAMA, the Brazilian Environment Institute, but the right of use is to be

transferred to local forest dwellers, probably through some sort of ownership title. Although the demarcation of these reserves should ease tension in areas of recent violence between extractivists and ranchers, the issue of title, along with the task of making these reserves viable economically, are only two of the many complicated issues that remain to be worked out. IBAMA will be in charge of supervision and enforcement, along with state police.

243. The Brazilian rubber industry has depended wholly on protection from foreign competition through tariffs and market reserve policies. If these are effectively removed, and the current duty on natural rubber (40%) determines the domestic price ceiling, there is likely to be little interest in wild rubber extraction in the future.

244. Discussion and Conclusions. Extractivism is no panacea for the preservation of the Amazon. Studies which have shown that a hectare of land used for extractivism is worth more than a hectare in livestock or crops have missed the point: the rancher or farmer is living much better than the extractivist. Given the opportunity the extractivist will become a rancher. Only if extractivism can provide a quality of life (including potential for the future) comparable to perceived alternatives will it have a reasonable chance of competing with other claims for Amazonian land.

245. Prospects cannot be considered bright. First, extractivism is by its nature extremely labor intensive and necessarily involves a degree of isolation inconsistent with the economic provisions of health and education services. The decision being made by many extractivists to abandon the activity in favor of garimpagem, agriculture, or city life, is for them a decision to seek a better future for their children.

246. The market of potential Amazonian forest products is also dim. Almost any Amazonian product that could find a large market in North America would probably find its market invaded by competitors from other areas with lower transport costs (California, Florida, Hawaiian Islands, Caribbean Islands, Fiji, etc.).

247. Even though extractivism is unlikely to compete effectively in a free market for inputs and outputs, it may perform an important role in reducing the cost of protecting critical areas (e.g., areas of high biodiversity or critical watersheds). For such critical, well-defined areas the government (or, in the case of biodiversity, international efforts) may provide public services, and even facilitate the marketing of extractivist products in exchange for land occupation and land protection services.

Large-Scale Mining

248. Background. The mineral wealth of the Brazilian Amazon is estimated at $3 trillion, with deposits of gold, bauxite, tin, copper, uranium, potassium, iron ore, rare earths, niobium, sulfur, manganese, schist, diamonds, and other precious stones. New mineral deposits are discovered each year. In 1990, for example, new tin ore and gold deposits were discovered in Rondônia. Other sites,

including the giant Salobo[59] copper reserve (in the Carajás range), have not yet been fully explored.

249. The significant deposits of important minerals in the Brazilian Amazon have helped make Brazil an important world producer. Brazil is the world's largest cassiterite producer (all from the Amazon), the third most important iron ore producer, and has the third largest world reserves of bauxite (90% in the Amazon).

250. Pará, in Eastern Amazônia, is the state with the greatest intensity of mining activity. Although only 10,400 km^2 (or .8% of the state's land) is actually being mined, roughly 36% of the State (449,263 km^2) is under official concession to mine or prospect. Current large-scale mining operations in Pará include those for iron ore, manganese, and bauxite. The states of Amazonas and Rondônia are next in the importance of their mining activities, with recently exploited tin ore (cassiterite) deposits, followed by Amapá, with the ICOMI manganese mines started in the 1950s by Bethlehem Steel.

251. Within Pará, the largest currently identified area of mineral wealth is the Carajás range. The region's promise as a significant mineral reserve began to draw major world attention when, in 1967, US Steel geologists discovered one of the world's largest iron-ore reserves. In addition to reserves currently estimated at 17.8 billion tons of high quality iron ore, the Carajás range contains deposits of manganese, copper, nickel, bauxite, and gold.

252. Government Involvement. Large-scale mining in the Amazon has benefitted from active government involvement and a range of special subsidies and exemptions. Formulated in 1974, both the Second National Development Plan (PND II) and the POLOAMAZÔNIA (Program of Agricultural and Mineral Poles in Amazônia) provided strong support for the formal mining sector.[60] Mining and associated projects receiving special attention included the Carajás-Itaqui iron-ore and steel-making scheme, the Trombetas-Barcarena bauxite-aluminium complex, and the hydroelectric schemes for the Araguaia-Tocantins region.

253. In 1980 government created an overall program for the development of the Carajás region, named the Greater Carajás Program (PGC) of which the Carajás iron ore mine was to be the centerpiece.[61] This PGC was instituted by decree-

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/59 Salobo has an estimated 1.2 billion tons of copper ore. Its total production capacity is estimated at 86,000 tons of copper concentrate a year (Gazeta Mercantil 1/29/90).

/60 Large-scale mining in Amazônia began in the 1950s with manganese mining in Amapá carried out by ICOMI (a consortium of the Brazilian Azevedo Atunes group and Bethlehem Steel). By 1987 ICOMI mined 1,355,768 tons of manganese valued at over $28 million (Anuário Mineral Brasileiro 1988).

/61 Initial plans to exploit the Carajás deposit, developed in 1974, involved a joint venture between US Steel and the state-owned Companhia Vale do Rio Doce (CVRD). Following several years of delay by US Steel, resulting largely from the plunge in world steel and iron ore prices, US Steel in 1977 sold its stake to CVRD.

law in 1980 with the broad objective of developing the region into a major center for mineral resource-based industries. Projects in the official Carajás region offered exemptions from income taxes, manufactured products taxes, and import duties. Of the estimated $61.7 billion required to implement the PGC over the period 1981-90, $35 billion was to go to mineral activities, with 95% of that amount going to 4 mega-projects: Carajás Iron Ore, ALBRAS-ALUNORTE, ALUMAR, and Tucuruí (described below) [Neto, Forthcoming].

254. With full government support (through the PGC), funding, and market outlets, CVRD was able to implement much of the Carajás Iron Ore Project by 1986, creating a highly mechanized open-pit mine and processing facility. By 1989, this facility was producing between 30-32 million tons of ore annually in one of the largest open-pit mining operations in the world.

255. The project also included the construction of 890 km of railway, a deep-water port capable of handling ships of up to 350,000 dead weight tons, two new townships, and other important basic infrastructures, including the construction and/or paving of 170 km of highways (PA-275 and PA-150).

256. Total project design and execution costs were eventually assessed at $2.8 billion, of which the World Bank financed roughly $240 million and other international lenders provided $914 million (See OED Case Study of Carajás 1990).[62]

257. ALCAN (Aluminum of Canada) discovered a large bauxite deposit in the Trombetas area of north-western Pará in 1967. This $400 million project opened in 1979, run by a consortium led by CVRD/MRN (Mineração Rio Norte).

258. Consistent with the PGC's goal of maximizing the regional value added from mineral exploitation activities, two separate joint ventures between CVRD/MRN and Nippon Amazon Aluminium Company (NAAC) were developed, with the goal of transforming the bauxite ore into alumina and primary aluminium. For its part, the Brazilian government agreed to provide support infrastructure, including a port and subsidized hydroelectric power (over a 20-year period) through the Tucuruí hydroelectric project on the Tocantins river. The two ventures were the Alumínio do Brasil (ALBRAS) with an expected annual production of 320,000 tons of aluminium and the Alumina do Norte (ALUNORTE) with an estimated annual production of 800,000 tons of alumina.

259. Effects on the Environment. Although large-scale mining in Amazônia generates significant amounts of wealth, it does have environmental and social

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/62 According to the OED Case Study (1990), World Bank funding was a key element in assuring resources for the undertaking from other lenders. At approval, Carajás represented the single largest Bank loan to Brazil and one of the largest made by the Bank anywhere in the world. It was also the first time the Bank had financed an integrated mining, rail, port infrastructure project through a single loan. Moreover, the Amerindian "special project" was the first concrete application of the Bank's policy on tribal peoples. Although neither the Amerindian nor environmental component was directly financed with Bank loan resources, both were contemplated in the Loan and Guarantee Agreements.

consequences, including deforestation, contamination of rivers, and the disruption of local communities. It appears that while direct environmental consequences of formal mining can be, and generally have been, minimized, indirect effects and associated development activities can have much more significant impacts.

260. For example, the manganese deposits in Amapá were developed by Bethlehem Steel in the 1950s with virtually no environmental planning or safeguards. Because development in Amapá has never grown beyond mining, railway, port facility, and a small agricultural sector, however, Amapá has the lowest rate of deforestation in the Amazon, affecting less than 1% of the state.

261. Carajás, on the other hand, was primarily developed over the last decade with CVRD directing significant sums to environmental planning. Between 1982 and 1987 CVRD invested about $64.4 million (2.2% of total project costs) in zoological, archaeological, and botanical research (under the supervision of the Museu Goeldi in Belém), pollution control, and the regeneration of degraded areas (OED 1990).[/63] CVRD's Carajás mines have become an environmental showpiece for a government eager to respond to critics of the environmental destruction associated with Amazon development.

262. Although impressive, the environmental protection component of CVRD's effort was (necessarily) limited to the areas under CVRD's direct control. Unlike the relatively remote mines of Amapá, the Carajás range in central Pará is in an area that was already starting to develop. Although CVRD mining operations in Carajás destroyed relatively small amounts of forest directly, the associated development boom, including the installation of major infrastructure (road, rail, and hydropower), agricultural settlement projects, ranching, logging, and garimpagem have accelerated large-scale deforestation. Much of this development would not have been possible without direct support through a variety of government development initiatives, including PIN, POLOAMAZÔNIA, and the Greater Carajás Program.

263. In its report entitled Environmental Aspects and Consequences of the Carajás Iron Ore Project, OED (1990) concludes that while many exemplary environmental measures were taken in areas under CVRD's immediate control, environmental preservation and control were lacking outside of this area, "strongly contributing to a situation of largely uncontrolled rural settlement and urban development, accompanied by increasing environmental devastation (pg. 118)." The report suggests that while the Carajás Project is an example of effective environmental management with respect to the installation and operation of large mining and transport facilities, it also represents a case of inadequate

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/63 The 1990 OED Report states that nearly 90% of project environmental protection costs were concentrated in hydroseeding, landscaping, and drainage measures. These efforts (in addition to their environmental benefits) were also essential for project operation and maintenance of infrastructure. Anderson (1989) states that while the above aspects were exemplary, environmental monitoring, education, conservation, and basic research components were weaker.

environmental planning and control in the larger region that was directly and indirectly affected by these investments./64

264. Charcoal Production and Pig Iron Smelting. Large-scale mining in Carajás has also led to the use of charcoal for the smelting of pig iron from the Carajás Iron Ore mine. In a project announced 8 years ago, the Brazilian government promoted the installation of 13 pig iron mills to serve the Greater Carajás Project./65 These pig iron milre initially used charcoal produced from natural forest areas in Maranhão and Pará States.

265. Currently, four of the mills are operating, providing employment for thousands of workers in the region./66 Environmentalists have consistently condemned the scheme because of its contribution to deforestation. The mills produce about 240,000 tons of pig iron per year (OED 1990: 147). Once all the smelters are installed, the total productive capacity per year will be around 1,578,000 tons per year. Anderson (1989: 150) estimates that despite IBDF regulations, charcoal-consuming industries in the Carajás corridor may eventually result in the deforestation of some 1,524 km^2 per year./67 At this rate, ignoring natural regrowth, the area under the influence of the PGC would be deforested in 70 years.

266. In 1988, 17 organizations concerned about the scheme's environmental impacts brought civil action demanding the suspension of the projects. The mills, however, are continuing on schedule with 4 new mills scheduled to come on stream by August 1990 pending the decision of the Federal Appeals Court in Brasília.

267. The Nossa Natureza Program, announced in April of 1989, requires that companies deforesting the area, repl[illegible] the trees. In addition, IBAMA requires that companies using more than 8,400 m^3 of wood a year supply 40% of their own charcoal needs. By 1995, this requirement will become 100%, though an exception will be made for companies engaging in reforestation who may continue to purchase

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/64 The OED study further states that "while credit for the former can be attributed jointly to CVRD and the Bank, which insisted on proper environmental protection measures in connection with the Carajás Project, blame for the latter must also be shared between the two" (p. 118).

/65 The establishment of industries based on pig iron was part of CVRD's strategy from the outset, and hence became integrated into the Grande Carajás Program design as it developed (OED 1990; Anderson 1989).

/66 The OED Case Study of Carajás (1990) calculates that 12 of the pig iron smelters, when fully operational, would employ about 4,524 people directly (see OED Report Annex II).

/67 Estimates of the amount of forest destroyed annually to supply these furnaces (once fully operational) varies from 1,000 km^2 per year (Fearnside) to 2,337 km^2 (Valverde 1989). For further information see OED Carajás Case Study (page 150).

20% of their charcoal from other firms./68 Although 2 of the largest companies have already begun forest management projects involving the harvesting only of certain size trees and the replanting of certain tree varieties in 15-year rotation cycles, ecologists argue that the proposed size of the management areas does not allow enough time for the forest to regenerate.

268. Discussion: Mining, Planning, and Government. Large-scale mining projects generate three types of problems: environmental preservation problems, pollution problems, and public finance problems.

269. Preservation problems are those discussed in Chapter I--greenhouse gases, climatic changes, and the destruction of genetic resources. These are classic externality problems coupled with an unusually high degree of scientific uncertainty. This class of problems cannot be approached on a project-by-project or program-by-program basis. It must be part of a worldwide biodiversity protection program, which includes international support and recognition of the opportunity costs of development.

270. Pollution Problems. Unlike preservation problems, pollution problems are felt within the project area. They range from direct effects (dust) in the mine environment (better perhaps considered an employment issue rather than a "classical" environmental issue)/69 to pollution of rivers and streams and endangered downstream populations. With costs and benefits internalized within the region, it may be possible to develop appropriate systems of taxation and/or compensation.

271. Summary and Recommendations. Large-scale mining will continue to be a major force for economic development in the Amazon. Combined with government and agricultural production for the local market, it can contribute substantially to the development of stable and integrated economies in the Amazon.

272. The role of government must be carefully considered, by both the Bank and the Brazilian authorities. The frontier offers large opportunities to waste resources in trying to anticipate the direction of private sector forces, which suggests that (the federal) government should only become involved in providing

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/68 One of the largest pig iron producers is beginning a venture to harvest timber from the Tucuruí Dam lake bed where there is an estimated 6 million cubic meters of quality hardwood. The submerged wood is cut by divers using special chain saws and working at depths of up to 50 meters. According to those involved, harvesting is much cheaper than on land (Gazeta Mercantil February 12, 1990).

/69 This distinction is based on whether or not the costs of the pollution extend beyond the area controlled by the decision-making body. If they are fully contained within the project area, the project management unit should seek to reduce pollution to economically optimum levels. Whether or not there is a public role to reduce pollution levels to yet lower levels (e.g. to protect workers' health) is a question where legitimate differences of opinion can exist. The closer the markets approximate to the neo-classical competitive model (e.g. perfect information), the more defensible the argument is for non-intervention.

infrastructural services after the frontier is relatively well established. Government activity at the frontier may best be limited to facilitating the use of contracts (including ownership), enforcing laws, and adjudicating regional externalities, within the context of a strategy with respect to global resources.

Hydroelectric Development

273. Background. Over the last decade, large hydroelectric projects have figured prominently in government efforts to develop the region. In 1980 Amazônia had only two small hydroelectric dams covering an area of less than 100 km^2 and producing only 70 MW (megawatts). This changed dramatically with the construction of the Tucuruí on the lower Tocantins, covering an area of 2,430 km^2 and with a potential generating capacity of 8,000 MW. During the early 1980s, other large projects were begun, most notably Balbina (near Manaus) and Samuel (near Porto Velho).

274. Developing the hydroelectric potential of the Amazon is contentious. That potential is enormous and virtually untapped. If fully utilized, the Amazon basin could produce an estimated 97,800 MW (megawatts) of power, out of a total 213,000 MW estimated Brazilian hydroelectric potential (Mougeot 1990). When complete, the Tocantins-Araguaia system alone could satisfy around 15% of the nation's energy needs.

275. Only 14% of Brazil's hydroelectric potential has been tapped. Until 1995, this potential will increase at an expected annual rate of 11.3%, with installed capacity rising from 34,035 MW in 1983 to 55,382 MW in 1990. The average size of Brazil's hydroelectricity plants has grown steadily since the mid-1930s. Future growth in supply is expected to come from fewer schemes with ever-growing generating capacity. Average installed capacity per plant has grown from 83.66 MW in the mid 1960s to 2882.43 MW by 1990 (Mougeot in Hall 1990).

276. For the Amazon to achieve its full hydroelectric potential, ELETRONORTE (the federal power-utility holding company's subsidiary for northern Brazil) calculated in its "Plan 2010" that as many as 63 reservoirs might have to be built, 27 alone in the Tocantins-Araguaia system. Although the Amazon has vast water resources, the relatively flat relief and extremely wide flood plains make the region geo-morphologically poor for dams. Hence, approximately 100,000 km^2 would be flooded if all the dams were built. Although this is not a major portion of the total land area of the Amazon, its effect on tribal people would be serious./70

277. Over the last year, ELETROBRAS's "Plan 2010" has undergone some revision in an effort to reconcile energy generation with environmental and tribal people considerations. The March 1990 version of this master plan, announced the cancellation of 5 planned hydroelectric projects and the withdrawal for reassessment of another 5 projects located in Amazônia. These were expected

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/70 This represents approximately 2% of the area of the legal Amazon, or the equivalent of the land set aside for reserves in Rondônia.

to have major environmental impacts./71 These alterations will reduce by 6,500 MW the quantity of electricity projected for Brazil in "Plan 2010." At the same time, energy demand in Brazil seems to have grown slower than expected over the last several years (Gazeta Mercantil, January 22, 1990).

278. Possible Environmental Consequences of Hydroelectric Projects. Even without extensive human landscape alteration, reservoir creation could significantly change Amazon ecology and hydrology. In many natural floodplain areas of the Amazon, plant, animal, and fish species are adapted to spending up to 50% of the year in submerged floodplains. Around the reservoir, new areas not adapted to floodplain life will be periodically flooded by only small increases in the water level. An increase of 4 meters at Balbina could flood 800 km^2 of forest (Junk and Nunes de Melo, 1987). Before these new areas can be colonized by flood-resistant communities, many species may die, creating the potential for increased erosion and sedimentation. Particular care must also be taken when special biological reserves are threatened by hydroelectric dams, such as river beaches where endangered turtles breed.

279. Most economically valuable fish in Amazônia are migratory. Their normal migration routes may be destroyed as a result of dam construction. Many of these species are reported to have been significantly reduced in the Tucuruí area as a result of the Tucuruí dam./72 Declining fishing stocks might be ameliorated by stocking the reservoirs with appropriate adapted species, although controlling and anticipating the environment within these reservoirs is very difficult.

280. Planned Hydroprojects and the Disruption of Human Populations. In terms of their effects on forest-dwelling populations, large hydroelectric projects and their related infrastructure may well be the single most disruptive development actions in the Brazilian Amazon in the near future. Because little has been done in the way of local ground surveying, it is difficult to estimate the resident population of proposed reservoir sites accurately. Mougeot (1990) reports that if the impoundments currently contemplated had all been created by 1985, they would have displaced between 85,000 and 156,000 residents.

281. Policy Issues. Clearly, there are a great number of issues (huge areas flooded, low power ratios, and siltation that shortens reservoir life span) that must be weighed prior to the construction of hydroelectric projects in the complex Amazon ecosystem. For the nation as a whole, the cost of hydropower from the Amazon must be considered alongside the social, economic, and environmental costs of other energy alternatives elsewhere in Brazil. A fundamental issue is the extent to which new dams would be required under a regime of full-cost energy pricing.

/71 The canceled projects include the Santa Isabel, planned for the Araguaia in Pará, which would have flooded much of the land of the Karaja Indians (Gazeta Mercantil, January 22, 1990).

/72 Some of the problems associated with migratory fish could be reduced by the construction of "fish steps" which would allow the fish to get around the dams. These are not included for the Tucuruí dam.

282. Junk and Nunes de Mello (1987) suggest that environmental problems would certainly be reduced if projects were developed only in those basins which offer the greatest energy returns and then transported long distances, rather than following through with the construction of many smaller isolated reservoirs throughout the Amazon.

283. Because of the significant negative environmental costs, schemes that provide relatively low energy returns should probably be abandoned. While Tucuruí can provide in excess of 4,000 MW, Balbina will only be able to produce 250 MW. Balbina also does not compare favorably in terms of energy produced relative to area flooded: Itaipú, in southern Brazil, produces 9 MW for every square kilometer flooded, while Tucuruí has about 3.3 MW/km^2 ratio. Balbina, on the other hand, only has about 0.1 MW/km^2. In the long run, Balbina will probably not even be able to supply Manaus, requiring the transmission of power from somewhere like Tucuruí (Junk and Nunes de Mello 1987).

284. Provisions for reducing the environmental and social impact of large-scale hydroelectric plants, written into the new "Plan 2010," will probably add 15-20% to the cost of each future project. Compared with the costs incurred in past projects which dealt with disruption of local communities ex post, these expenditures may be a sound investment.

CHAPTER III

SUMMARY AND ANALYSIS OF POLICY INSTRUMENTS

285. The previous sections have focused on the economic forces influencing human activity in the Amazon. The purpose has been to understand these forces better, so that appropriate environmental and land-use policies might be developed. Up to this point normative judgements have been generally avoided--the emphasis has been on obtaining an accurate perspective on the causes and magnitudes of environmental change.

286. This chapter is organized into three sections. The first section briefly reviews the nature of the non-priced costs resulting from the economic activities reviewed in the previous chapter, and sets out the implications for future forest conversion. The second section reviews the economic and political setting for environmental policy in the Amazon. It summarizes the main conclusion concerning economic factors discussed in the previous chapters, and highlights the implications of political events which have, over the past two years, significantly changed the framework in which environmental and developmental policy for the Amazon will be determined. The third section outlines the elements of an environmental strategy intended to achieve the greatest social benefits from the Amazon.

A. Summary of the External Costs of Amazon Development

287. Table III-1 summarizes the social and environmental costs of the economic activities reviewed in Chapter II. Not surprisingly, the critical environmental factor is forest burning. External costs associated with hydropower development and large-scale mining are largely those associated with resettlement biodiversity and indigenous disturbances--so much of the environmental damage is potentially controllable. The social costs of placer mining are generally recognized by the participants, but the full environmental and health effects of mercury contamination on either the miners themselves or on downstream populations (human and non-human) is not yet known.

288. Logging under Amazonian conditions causes relatively little direct environmental damage. Erosion is the major external cost of logging at current intensities and is primarily caused by road construction. Depending on logging's intensity, it may or may not significantly alter the species' richness. The critical environmental impact of logging is indirect--to create access to land for farmers and ranchers who follow.

289. How much land in the Amazon should be preserved to balance environmental objectives against the production of food and fiber? Current knowledge of Amazonian resources does not permit this question to be answered with confidence. It is clear, however, that burning is the environmentally critical activity. First, it converts biomass to CO^2, resulting in global warming costs estimated at some US$1,300-5,700 per hectare (see para. 61), far more than the market value of land currently under conversion in the North. Second, one of the most important agricultural benefits of burning, the elimination of unwanted species competition, is an immediate external cost in terms of lost species diversity. Third, loss of forest cover creates erosion

Table III-1: SOCIAL AND ENVIRONMENTAL COSTS OF SELECTED ACTIVITIES IN THE AMAZON

ECONOMIC ACTIVITY		DOMESTIC			INTERNATIONAL	
		UNANTICIPATED SOCIAL COSTS	SOIL EROSION DUE TO WATERSHED DISTURBANCES	CLIMATIC CHANGE: BRAZIL	CLIMATIC CHANGE: INTERNATIONAL	BIODIVERSITY
Hydropower Development		Potential problems of resettlement and disturbance of indigenous populations	Usually controllable	No effect	If all proposed damsites were burned, global warming damages would approximate that from 2 years of deforestation at the current rate	The effect on fish and water species is not yet documented
Forest Extraction		Generally unacceptably low consumption standards when in competition with other economic activities	None	No effect	No effect	Benign
Large-scale Mining		Potential problems due to spontaneous development	Controllable	No effect	No effect	Minimal area involved
Placer Mining		Social costs are generally recognized. Full seriousness of mercury contamination of miners may not be yet understood	Locally serious	No effect	No effect	Miners have invaded previous pristine areas, but overall effect on land areas is minimal. Effect of mercury contamination of fish and riverine species is not yet known.
NUTRIENT MINING	Timber High-grading	Insignificant	Roads may cause local erosion problems, but overall effect is generally minimal	No effect	Carbon sequestering may reduce greenhouse gases slightly	Minimal Effect--can be controlled through management
	Softwood Logging	Insignificant	More intensive removal of trees may cause serious erosion on hilly land	Could make forest flammable	May sequester carbon	Less selective harvest of trees is likely to lead to substantial disturbance and species loss
	Annual Cropping	Previously high, however there are currently few illusions concerning the likelihood of agricultural success in the Amazon	Depends greatly on local sites. Eighteen percent of the land in the North would require "high" or "very high" costs for conservation measures if it were to be cropped substantially	Depends critically on the rate of vegetation (see text)	Estimated global warming damage from burning one hectare of tropical dense forest is US$450-$1500 per hectare	Burning is the major destroyer of species. Some 8-10% of the Amazon has been rated as "highest priority" for reservation for endemic species
	Cattle Ranching	Problems of land disputes	See above	See above	See above	See above

problems and affects watershed functions.

290. Current best estimates suggest that the present value of the marginal costs to society of adjusting to global warming resulting from burning a hectare of land (say US$2,200) exceeds the present value of the future agriculture benefits as reflected in the price of land (say US$20-300). It is economically irrational--from a global point of view--to burn Amazon forest for agricultural benefits.

291. As reviewed in Chapter I, it is impossible to evaluate the economic tradeoff between preserving biodiversity and agriculture. The current consensus among biological scientists with expertise in the Amazon, based on the Workshop 90 conference held in Manaus, is that, as a matter of first priority, some 8% of the Amazon should be preserved to maintain the world's genetic inventory./73 Preserving the two highest priority areas (out of 6 comprehensive classes) would entail setting aside 28% of the Amazon. The results of the conference do not yet permit the relative importance of each category to be evaluated.

292. An upper limit of the amount of the Amazon that would have to be set aside to protect watersheds might be gleaned from the soil survey work of EMBRAPA-CIAT, in which 18% of the land in the Northern regions was classified as both "agricultural" and implying either "high" or "very high" conservation costs to be farmed sustainably. Its "agricultural" classification suggests that it could yield at least temporary agricultural benefits and therefore, if not controlled, would eventually come under agricultural pressure. Since it is impossible to tell from this data whether or not the resulting erosion would create downstream watershed damage (or benefits), this 18% figure is an upper limit of the amount of land that would have to be set aside for erosion protection purposes.

The Economic Environment

293. It is one thing to indicate what is rational from a global perspective. It is quite another to alter local economic forces to bring about globally desirable results.

294. The economic forces encouraging deforestation were analyzed in Chapters I and II. The major conclusions from that analysis are: (i) expansion of Brazil's frontier is slowing, due largely to changes in demographic factors and to lower expectations about the quality of life on the frontier; and (ii) expansion will not come to an end simply by terminating the promotional policies of the past. These conclusions suggest that there is time to develop sensible and effective policies, and that the costs and benefits of measures to actively reduce deforestation-related externalities will have to be faced realistically.

295. The economic pressure behind current agricultural activity in the Amazon is nutrient extraction. Nutrients, currently embodied (largely) in the

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/73 These data, based on the results of the January 1990 Manaus conference on Biodiversity (Workshop 90), refer to the Amazon River Basin, not the Brazilian Legal Basin. The distribution of priority areas in the Brazilian Legal Amazon is not likely to be markedly different from that of the basin as a whole.

canopy of the forest, can be extracted and sold in a variety of forms--most importantly trees, crops, and meat. This process of nutrient mining varies somewhat from region to region along the frontier, depending on the quality of soil, ease of forest access, availability of labor and credit, and land tenure relationships. In fact, in some cases the cropping stage may be skipped, if, for example, soils are particularly poor and markets for low-grade timber (or charcoal) have evolved./74 Also, the various stages of production may be carried out by different actors, with the land changing hands numerous times; alternatively the land may be exhausted under one owner as part of an integrated operation. Whatever specific economic form in which activity evolves, however, the process is best understood as one of private maximization of the value of the nutrients mined net of extraction costs.

296. As with any other form of mining, nutrient mining is not sustainable (geographically stable)--when nutrients are depleted beyond a profitably extractable level, the activity must relocate to a new area. Extraction time has generally been on the order of 10-20 years, depending on the initial fertility of the soil.

297. Three aspects of nutrient mining are essential to an understanding of the political-economic dynamics of the frontier. First, from the individual's point of view, nutrient mining is a rational approach to agriculture in a land-surplus economy./75 Comparing the costs of fertilizer and chemical pest control in geographically stable agriculture with the natural fertility and relative absence of pests in new lands (especially after burning), the price of new land is a bargain. Second, whether a given farmer or rancher intends to remain (geographically) stable or not, economic forces will probably force him to adapt to a land-surplus economic environment./76 And third, the 10-20 year time period for nutrient depletion is probably beyond the time horizon of most local decision-makers. Thus proposals to lengthen the active life of the mine (viz adopt "sustainable" techniques)--would find little local political support if they came with a significant reduction in current economic activity and profitability.

/74 Availability of these alternative markets often justifies the marketing of nutrients in the form of wood rather than as crops (after burning the wood).

/75 Ester Boserup (1965) discusses the changes in primitive agricultural techniques from forest fallow to bush fallow to continuous cropping as population pressure shortens fallow periods. Her conclusion is that each increasingly land-intensive stage is adopted only under the pressure of population, precisely because it requires increasingly more labor input. Although these conclusions may not apply generally in the Amazon, it is nevertheless true that it is often easier (and cheaper) to move to (and burn) new land than to purchase and apply chemical fertilizers and pesticides.

/76 For example, under economic pressure from labor shortage (high labor costs) and low crop prices, farmers in Rondônia are uprooting treecrops, planted to provide a geographically sustainable income, in order to establish (geographically unsustainable) pasture that is less labor using.

298. These three characteristics of Amazonian agriculture make it difficult to enforce policies intended to control the deforestation process and to stabilize the agricultural frontier. They are also expensive--unless the underlying profitability of nutrient mining is altered, few people on the frontier have an incentive to see it ended. This suggests two guiding principles for directing development policies in the Amazon. First, where possible, economic and political-economic incentives must be made consistent with the desired outcome. Second, policies based on enforcement will be difficult to implement and should be used only selectively.

B. The Changing Political Environment

299. As discussed in Chapter I, past government policy was oriented strongly toward promoting development in the Amazon. The principal factors attracting migrants to the Amazon since 1965 have been ambitious settlement projects--along the Transamazon highway, as part of the National Integration Program, and in Rondônia. These projects were made possible by a massive federal road-building program, and were supported by policies intended to distort prices in favor of the migrants. Government programs provided access to the Amazon and encouraged settlement, which created the potential for environmental problems; government price policies exacerbated the problem.

300. While Amazonian settlement was largely induced by public policies, the fact that the Government created the situation does not mean that the Government currently controls it. Although public policies on Amazonian development have changed greatly over the past 15 years, current economic and demographic forces may be relatively insensitive to the changes.[177] A more democratic regime may also have more difficulty making its will prevail.

301. Several factors suggest that the past massive federal expenditures in the Amazon will not be repeated. First, with only 5% of the nation's voters, the Amazon is not likely to be a recipient of major expenditure under a democratic regime. And the lesson that investments in the Amazon generally waste money and create new problems appears to have been learned, making massive investment unlikely under any political scenario.

302. The power and sophistication of the states has recently grown, primarily due to increased revenues under the new Constitution. But this is not necessarily a positive factor from an environmental point of view. Local governments depend on local resources (i.e. "development") and population, and may have little incentive or ability to regulate negative social or environmental consequences. They are also sensitive to the needs of their local electorates. Consequently, in many areas where nutrient mining is the dominant economic base, decentralization may weaken the federal government's leverage as it seeks to reduce environmental externalities and to protect small and vulnerable groups like Indians and traditional extractors.

/77 For example, colonization was officially de-emphasized in the early 1970s in favor of large enterprises, although in fact it continued in response to pressures of the migrants arriving on the frontier.

303. In sum, future economic and demographic trends in the Amazon will probably depend less on policy initiatives at the central level and more on "spontaneous" processes and local policy initiatives. Similarly, this local economic and policy environment will determine the fate of environmental measures.

304. Current environmental policy in Brazil in general, and the Amazon in particular, will be shaped strongly by the legal-institutional framework of Brazil's new Constitution (October, 1988) and the "Nossa Natureza" program (April 1989). The Nossa Natureza program eliminates several of the most visible incentives to clear land in the Amazon, namely fiscal incentives for new large-scale beef cattle ranches in forested areas. It also reverses legislation that encouraged land clearing as proof of occupancy for purposes of establishing land title. The new Constitution significantly decentralizes environmental monitoring and enforcement by shifting responsibility to the states for most licensing, monitoring, protection, and law enforcement functions. Encouraged by the federal government through SEPLAN and IBAMA, as well as by FAO and the World Bank, Amazonian states have, in general, embraced some form of land use planning as the vehicle to meet their new environmental responsibilities.

C. An Environmental/Developmental Strategy

305. The overall thrust of the proposed environmental/developmental strategy for the Amazon is to allow development only where the overall social benefits to Brazil are positive, and, where appropriate, to seek mechanisms to allow the rest of the world to reimburse Brazil where global costs exceed Brazilian benefits. A central consideration in this strategy is the weakness of both the institutional capacity and incentives at the local level to restrict environmentally damaging activity.

306. The proposed environmental strategy consists of policies directed toward four areas: (i) forest access policy; (ii) policy distortions; (iii) preservation of special areas; and (iv) market-based mechanisms. These are addressed below.

Control Forest Access

307. A forest access policy is the first order of priority. As previous chapters have repeatedly shown, the most environmentally important government activity in the Amazon is the provision of access to new land. And as development along the Transamazônia shows, transportation infrastructure is the major determinant of the opening of new lands. The influx into Rondônia and Acre followed BR-364, and the more recent development in the zone of influence of the Grand Carajás followed the Carajás railroad and PA-150 and PA-275. Although there is some private roadbuilding primarily in conjunction with forestry, the extension and maintenance of these roads would be extremely limited without federal and state assistance.

308. For many roads in the Amazon, global externalities are likely to drive a large wedge between Brazil's interests and those of the rest of the world. Roads that are clearly in the interest of Brazil, even when local externalities (such as watershed damages) may often not be in the interest of the world as a whole, even when global damages are measured against Brazilian

The Limitations of the Market

Forests provide timber (and other marketable forest products), and environmental services (protect watersheds, sequester carbon, and conserve biodiversity). Cleared (previously forested) land can also be farmed, if only for a limited period of time. If all goods and services provided by forests, including environmental services, could be bought and sold, and land were owned with secure title, the tradeoff among forest functions, and between forest and non-forest uses of land would be determined by the public's wiliness to buy the different services: if the public preferred the services of the intact forest over timber and agricultural products, the landowner would be paid more to preserve the forest than to convert it to agricultural use.

Unfortunately, because there is no market for the forest's environmental services (because it is impossible to restrict the benefits of the forest's environmental services to those who pay for them), a land owner can benefit from owning forest land only if he logs it and/or converts it to agricultural use. Thus, left to market forces only, timber production and clearing for crops and livestock would be expected to be managed rationally over the medium to long term--environmental forest functions would be ignored.

Ideally, land owners making land use decisions (say to clear land by burning) would be obliged to weigh the social costs and benefits of their land use decisions equally with the private costs and benefits, resulting in a socially optimal production of food, fiber, and environmental services. Generally this policy would take the form of a tax on the social costs landowners would impose on society or a subsidy to prevent them from imposing the damages.

Institutionally, there are serious impediments to implementing such policies in the Brazilian Amazon--mainly institutional weakness and the impossibility of valuing social benefits realistically. Therefore, the policy mix recommended here, while recognizing the theoretical superiority of market-correcting policies, does not place heavy reliance on their effectiveness.

Box III-1

benefits. The policy challenge is, therefore, to reconcile Brazil's interest in rational exploitation of her resources with the importance to the rest of the world of reducing carbon emissions or protecting biodiversity.

309. Although a review of a roads policy is clearly beyond the scope of this report, the basic approach should insist that any road must be economically justified by Brazilian benefits; and that the rest of the world should pay for non-Brazilian net benefits./78 This (incorporating domestic environmental costs) requires: (a) that the objectives of building a given road be clearly stated, and the route and technique be identified that maximizes Brazilian benefit/cost (including domestic externalities); (b) alternatives be identified providing Brazil substantially the same benefits but at a lower global cost; and (c) the global incremental benefit/cost of these alternatives be evaluated as a complementary internationally financed project. If the benefit/cost of the

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/78 Mechanisms are becoming available to finance global benefits. The UN Global Environment Facility is one such mechanism. There are also precedents, such as the case of the energy utility in The Netherlands that was permitted to avoid costly pollution control costs at home by investing in pollution control in Poland and in tree plantations in Latin America. The European Commission has pressed member states to accept the stabilization of carbon dioxide emissions by the year 2000. UK economists have estimated that a carbon tax designed to freeze carbon emissions in the industrial sector would need to be set at US$25-50 per ton of carbon. With European firms facing this type of pressure, it is likely that lower-cost means of seeking a reduction in carbon emissions in developing countries will gain in popularity.

incremental project in Brazil is high relative to alternatives elsewhere, the world should pay for the incremental costs.

310. As an example, economically viable roads in the Amazon (excluding global externalities) would probably link Northern cities and the South, provide access to river ports, and open the way to new mineral resources. Based on experience in the Amazon to date, domestic benefits from agriculture induced alongside these roads would be minimal. In such cases, where it is clear that the road would attract settlement alongside, grant-based international financing could be sought for upgrading the road to limit access. In areas under settlement pressure it is not unusual for a kilometer of road to open up 1000 hectares of forest land. Using US$2,200 per hectare burned for the marginal global warming costs (see Chapter I, p. 22), the rest of the world could pay up to US$2,200,000 per kilometer to upgrade the road to limit access without global costs exceeding global benefits. This would permit the development benefits of the road to Brazil, while permitting the world (including Brazil) to protect its interest in controlling global warming.

311. The initial benefit/cost test of Brazilian benefits and costs is extremely important. Benefit/cost tests must be a major determinant in deciding which projects will be undertaken. In addition, the analysis should be transparent, and the alternatives carefully explored, including environmental implications. A great deal of misapplied Brazilian public funds could be saved if the initial economic analysis were done in a transparent and objective manner. This would also have the important side benefit of reducing potential global and environmental costs.

312. Additional tests will be needed to ensure that projected new roads are fully consistent with any land-use restrictions such as biological and indigenous reserves. These will be discussed below under the heading reserve areas.

Eliminate Policy-Induced Price Distortions

313. Government has historically intervened strongly in agricultural product and credit markets in Brazil. Some of these interventions have been oriented specifically toward encouraging agricultural activity in the Amazon. Others have had a less direct effect by tending to favor large farms and labor-displacing agricultural technology elsewhere in Brazil, thereby increasing the potential pool of rural migrants. Most of the programs reviewed below have become substantially less important over the past several years, due both to government recognition of the need for reform and the pressure of budgetary constraints. Though they have been diminished, those that remain continue to distort incentives, have negative environmental effects, and waste government resources. They should be eliminated immediately. They are outlined below:

(a) Price and tax policies that create incentives for agriculture in the Amazon:

(i) agricultural commodity price supports;

(ii) uniform fuel pricing policies; and

(iii) subsidized credit, especially from regional incentive schemes.

(b) Policies that increase migration to the Amazon by displacing rural labor in other states by subsidizing land-using, labor-saving technologies or land uses:

(i) differential tax rates tending to increase the north-south land price gradient;

(ii) farm commodity price supports that favor large-scale producers over operators of smaller units;

(iii) subsidized credit; and

(iv) failing to control inflation, which increases the demand for land as a store of value.

314. Policies Increasing Incentives in the Amazon ("Pull Factors"). Recent changes in agricultural price policies in the Amazon have generally tended to reduce distortions. Most importantly, the Government announced the regionalization of minimum prices supported by government purchases. Thus, in future, commodity pricing should reflect transport cost differentials more closely. In theory this should eliminate the subsidy to regionally marginal producers, especially those in the Amazon. The uniform diesel fuel price is still in place, however, and substantially reduces transport costs for producers in areas that sell food and fiber to distant markets. It also reduces the natural protection to producers in areas that are not self sufficient in foodstuffs (where local production destined for the local market must compete with food trucked in from outside). Despite somewhat ambiguous short-term environmental effects, the subsidy should be eliminated because it distorts transport costs and thus, in the long term, promotes the uneconomic location of enterprises.

315. The principal vehicle for tax relief on investments in agriculture and livestock has been the Amazon Investment Fund (FINAM), administered by SUDAM, the Superintendency for Amazon Development. In April 1989, fiscal incentives distributed by FINAM for agricultural and livestock development were suspended by Presidential Decree 97637, pending the completion of zoning exercises which would determine the areas eligible for stimulated development through fiscal incentives. In January 1991 incentives were reinstated, subject to conditions on the observation of environmental guidelines, consistency with regional development plans, and restricted to "regions of a recognized agro-pastoral vocation" in the case of livestock projects. This meant that only natural

pastures or already cleared areas can be used for livestock projects, and that further deforestation for this purpose was forbidden./79

316. The new Constitution has also established a credit fund, (based on 3% of the revenue from the tax on industrial product (IPI) and the income tax (IR)), to provide subsidized credit to investments in the North, Northeast, and Center West regions of the country. It is too soon to evaluate how this will work in practice. Finally, agricultural incomes have in the past been virtually exempt from taxation. This effect, as will be discussed below, has mainly operated through the land market to increase migratory pressure./80

317. Policies Increasing the Pull of Potential Migrants ("Push Factors"). Several policies have increased migration to the north, by encouraging labor-displacing mechanization and by artificially inflating land prices in the south. Subsidized credit had both effects: it lowered the real price of land and machinery, and it was heavily biased toward large enterprises. Similarly, large farmers were more likely than small ones to be able to take advantage of the minimum price program and subsidies to wheat and ethanol (sugarcane). Overall, the subsidy programs lowered the cost and increased the value of the output produced by large farmers relative to that of small (poor) farmers.

318. The differential between the taxation of agriculture and the taxation on profits from other sources created a powerful incentive for corporations and high income individuals to engage in agriculture. First, favorable income tax treatment made private and corporate investors willing to accept a smaller pre-tax rate of return in agriculture than in other enterprises. Second, it created a tendency to capitalize into the value of land the difference between the post-tax profit in agriculture and other enterprises. For example, with corporate agricultural profits taxed at 6%, and corporate profits from other sources taxed on average at 40%, agricultural pre-tax profit rates higher than 64% of profit rates on alternative corporate investments would tend to be capitalized into land values.

319. Because agricultural land in the south was both agronomically productive and close to market, the combined effect of subsidies and favorable tax treatment was rapidly reflected in land values, and almost certainly sharply increased the north-south land price gradient. As discussed in Chapter I, this sharp land price gradient was a principal factor leading smallholders to sell land in the south in order to increase their holdings with cheap land in the

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/79 Decree 101 of April 17 and decree 153 of June 26th further modified the regime. The position is now that fiscal incentives are "prohibited for projects that would entail deforestation in primary forest areas and destroy primary ecosystems." Projects are to be "oriented in accordance with the ecological-economic zoning, completed or in course," and must be examined by competent environmental agencies. Application of the rules is evidently contingent on the identification of primary forest areas and primary ecosystems yet to be defined by zoning exercises.

/80 Under the Collor Plan, tax shelters for large farms were reduced, and agricultural taxes reformed, eliminating some exceptions and deductions. Nevertheless, some distortions remain, such as tax-exempt accounts to finance agricultural operations.

north. Similarly, the large-farm bias of subsidies, and the additional tax-induced inflation in land prices, prevented those displaced through the labor saving bias of technological change from being able to compete for land in the south. These tendencies were exacerbated in the mid-1980s by near hyperinflation and uncertainty over future macroeconomic policies, both of which increased the attractiveness of land as a relatively secure store of value.

320. Under the new government, the agricultural income tax has been reformed, eliminating various deductions and exemptions and making rates comparable to those in other sectors. However, under the new tax law, producers can exempt income held in special accounts in banks that finance rural activities. It is too early to tell what, in fact, net effect the changes will have on effective agricultural tax rates.

Preserve Special Areas

321. The Brazilian Government has designated over 1 million km^2, approximately one-fifth of the Legal Amazon, as either reserves or parks (Table III-2). In practice, this designation has little meaning, because these areas receive minimal protection. A comprehensive study of Brazil's conservation areas, conducted by Anthony Rylands for the World Wildlife Fund, found that at present there is approximately one park guard per 6,161 km^2 of parks and reserves.[/81] In addition, IBAMA has legal title to none of the 8 National Parks, and to only one and 10% of a second of the 8 biological reserves in the Amazon (Lago Piratuba). The National Environmental Plan proposes a regime which would provide one park guard per 394 km^2 of conservation units. The national parks would have one guard per 5,188 km^2. Indian areas would have even less protection.

Table III-2: BRAZILIAN AMAZON: NATURE RESERVES NATIONAL FORESTS, EXTRACTIVE RESERVES, AND INDIAN AREAS, 1990

Type	Area (Km///)	Percent Total all areas
National Parks	93,011	8.10
Biological Reserves	29,028	2.53
Ecological Stations	26,950	2.35
Ecological Reserves	2,844	0.25
Protected Areas	14,566	1.27
National Forests	122,497	10.67
Extractive Reserves	21,630	1.88
Indian Areas	837,684	72.99
Total	1,147,710	100.00

Source: IBAMA and Rylands (1990).

322. Recently, a major initiative was launched to identify Amazonian areas especially rich in biodiversity.[/82] Scientists from a wide range of biological disciplines were asked to categorize, without regard for existing land-use designations, the land areas of the entire Amazon basin (not only the Brazilian

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/81 By way of comparison, Butler (1985) reported that CONSAG, the company that ran the Tucama colonization project in Pará, had a security force which in 1981 numbered 40 men plus several jeeps and a small airplane for surveillance of its 4,000 km^2 holding.

/82 This initiative, which convened scientists from around the world, was funded largely by the W. Alton Jones Foundation, and the World Wildlife Fund, and involved the cooperation of IBAMA, INPA, the New York Biological Garden, Conservation International, and the World Bank.

Amazon), into six biodiversity priorities. The scientists ranked approximately 8% of the land area as highest priority, with a total of 31% of the land in one of three highest categories. Forty-seven percent of the land was ranked as having no priority.

323. Although data are not yet available to provide a systematic comparison between current Park and Reserve lands and the preservation priorities, current indications are that the correspondence is poor.

324. In sum, the parks and reserves now face a lack of effective protection, lack of clear tenure arrangements, and unsystematic correspondence with biological criteria. Under these circumstances, a realistic reappraisal of the amount, location, and priorities of protected areas is called for, including an assessment of the policy tools that are appropriate for each. Possible policy tools are reviewed below.

325. Access Policy. A successful policy intended to reduce land invasion and halt forest burning must reduce the local benefits from burning, and increase local incentives to enforce land-use restrictions. The most effective way to do this has been discussed above--ensuring that new roads do not create incentives to violate the land use restrictions. This requires a significantly stronger policy than merely outlawing road building in reserve areas. It also means ensuring that new roads adjacent to reserves do not increase the incentive to log on neighboring reserve lands.

326. This could be formalized with the following litmus test for new infrastructure:

(a) The infrastructure must pass an economic cost/benefit test based on legal activity only; and

(b) The road must generate the fiscal resources necessary to finance the increased enforcement (or other measures) needed to control illegal activities. In the short run, it may be sufficient control if legal activities were simply made absolutely more profitable than illegal activities. Over the longer term, however, capital and labor would find their way into (less) profitable illegal activity also, and enforcement would be required.

327. Zoning is one way to influence land use decisions and has been much discussed in Brazil.[83] Current rural zoning in Brazil is essentially a resource inventory and mapping exercise--its policy content is far from certain. Initiatives to use this database to justify complicated, comprehensive land use/regional development schemes should be resisted, however, if for no other

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/83 Zoning exercises are being carried out in parallel by different Secretariats. In 1990 the Government appointed an Inter-Ministerial Zoning Commission to try to reconcile the separate approaches, which is due to report before the beginning of the UN Conference on Environment and Development in June 1992. On July 7, 1991, a Subcommission for Interaction was created to coordinate with state-level activities. Zoning Commissions have also been set up in the Amazon states: up to now the states have not applied zoning criteria.

reason than that they would waste scarce skilled manpower in an exercise that has few precedents for success anywhere in the world--much less in the Amazonian context (see Annex VIII). Highly selective zoning, designed to create buffer zones around (or in) parks and reserves, could possibly play a role in stabilizing agriculture and protecting reserve areas, however. To be effective, buffer zones would need three types of supporting policies. First, as discussed above, financial incentives for deforestation must be reduced. Second, viable, stable agriculture packages must be developed. Finally, enforcement efforts must be strengthened and participation by groups likely to favor enforcement must be ensured at critical junctures, in part by generating local revenue in connection with protection.

328. Eliminating and preventing the reemergence of financial incentives to violate zoning restrictions is an essential element of a zoning package. As reviewed above, much has already been accomplished. Additional measures which could potentially affect deforestation include the full elimination of fiscal and/or credit incentives to the wood products industry, and the elimination of the uniform fuel price policy, both of which have the effect of subsidizing transportation to and from remote areas./84

329. Successful zoning will also require that economic incentives to move into the reserve area from buffer zones or outlying areas be eliminated. Key to this are agricultural packages that make geographically stable agriculture competitive with transient nutrient mining. Unfortunately, for most soils of the Amazon, stabilized agriculture requires either expensive chemical inputs (fertilizers and pesticides) or high labor inputs (for green manures) and difficulties with pests. As reviewed in Chapter II, some success has been achieved under Amazonian conditions in Bolivia, but the overall record is bleak.

330. Effective enforcement of buffer zones is also tied to the level of resources available to the governing units--whether state, federal or autonomous (such as a park authority). The success of zoning enforcement is dependent on the development within these units of well-trained and well-equipped personnel. Long-run enforcement depends, therefore, on building the fiscal capacity to finance expenditure for zoning enforcement personnel, equipment, and training. Given the correct incentives to enforce zoning restrictions, a policy that enhances fiscal revenue will increase the probability of zoning enforcement.

331. Revenues can be increased by increasing the revenue from forestry activity in the buffer zone jurisdiction. First, the jurisdiction should capture part of the value of standing timber when public land is sold to private interests. This might require the development of a competitive bidding process for land, with certain minimum bids set by rough estimates of the timber value involved. Second, buffer zone jurisdictions might consider enacting a tax on cut timber, based on the establishment of a tagging system for logs, concentrating on key points such as critical road junctions and the main transportation routes leaving the region. The cost of personnel and equipment

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/84 As noted above, the uniform price policy for fuel clearly distorts regional production patterns. Its net environmental consequence is ambiguous, however. Although it subsidizes the wood product industry, it also reduces the natural protection of beef production in the north.

for operating the tagging system could be recouped from timber revenues collected.

332. Although state or federal government would probably have the primary authority for buffer zone enforcement, individuals and municipal governments might augment enforcement programs if appropriate incentives were provided. Individual incentives might be targeted at forestry guards or zoning enforcement personnel who might be allowed to keep a portion of the zoning violation fines collected as a result of their own enforcement actions. Similarly, municipal governments might be allocated a portion of the fines collected through zoning enforcement. Appropriate appeal procedures at the state level could ensure that individuals and municipal governments do not respond to fine-sharing by enticing or encouraging violations. The important principle is that individuals and municipal governments must be given a clear interest in zoning enforcement.

333. Individuals might also be given incentives to enforce the zoning by introducing the concept of "pre-existing non-conforming conditional use" into the buffer zone regulations. The designation of buffer zones should not be based solely on existing land uses. For example, if a particular area is designated as a biological reserve, agricultural operations that existed prior to the designation could be recognized and allowed to remain in the area, even though the new land-use designation prevents any further conversion of land to agricultural use. The new designation recognizes the "pre-existing" use but classifies it as "non-conforming." Zoning regulations often attach conditions to pre-existing non-conforming uses. For example, conditions could be attached to continued agricultural use of the land, such as limits on further expansion of the cleared area. In addition, non-conforming uses might be allowed to continue on condition that landowners prevent others from entering the area to establish agricultural operations. In effect, the existing farmers assist in reserve enforcement. The area that is already cleared for agriculture becomes a buffer zone in which agricultural activities are allowed to remain but not expand, and individuals are given a stake in maintaining the zoning boundaries.

334. In sum, although in well specified conditions zoning may provide some help in supporting a reserves policy, it is far from the panacea for land use conflict that it is often presented as being. In general, proposals to solve land use problems through zoning should be viewed critically. Until the planner's map can be supported by strong incentives and viable technology, zoning will do little to change farming behavior. The record to date gives grounds for skepticism./85 This is clearly an area where a wide range of models needs to be tested, but expectations should be low based on current evidence.

/85 In a case study of 23 Integrated Conservation-Development Projects (ICDPs) in Asia, Latin America and Africa, Wells et al (1990) found, "based on the case studies we have examined, progress [sic] so far has yet to make a significant overall contribution to the conservation of biological diversity". In addition, they report that a study for the IUCN Oilfield (1988) found very few examples of successful buffer zone management programs that "can really claim to have succeeded in establishing stable and compatible land use systems around a protected area in such a way that the local people are genuinely reconciled to the conservation function of the area".

Consider Market-Based Mechanisms

335. An "environmental" problem exists because individuals are able to use common property resources (or, equivalently, impose environmental costs) without paying for them (Text Box III-2). Currently, farmers contemplating agriculture in the Amazon pay, at most, for the scarcity value of the land. Given the

Forests and Land Tenure

The market value of land reflects buyers' expectations about the future income it will generate. It isn't surprising, therefore that in the absence of a market for environmental services, the price of forest land is low; the fact that forest land exists (hasn't yet been converted to agricultural use) is prima facie evidence that the land is exceptionally abundant relative to capital and labor (viz, is in surplus), is poorly accessible, and/or is agronomically unproductive. Pressure for deforestation and land ownership both begin to occur only when one or more of these factors changes and land becomes privately economically valuable.

Where, due to the reasons outlined above, forest land has no private economic value, the issue of land tenure is of minor concern. When new access, population pressure, and/or technological change begins to create the potential for people to profit from using the land however, claims of ownership soon emerge. Public and private institutions to register these claims, and to resolve competing interests begin to develop soon thereafter. In large measure the resources that public and private interests are willing to invest in establishing, clarifying, and enforcing claims is determined by the potential profits to be gained from owning land: where profits are low one observes poorly developed land institutions; where potential profits are high, land titling and enforcement institutions are sophisticated. Because of the low value of forest land, therefore, land tenure arrangements in forest areas is generally poorly determined. To compound the institutional problems, low land values are associated with a weak local economic base, and generally with poor local tax collections. This in turn exacerbates the weakness in local land institutions and law enforcement. Local vested interests often take advantage of and perpetuate these conditions.

Without land scarcity resources allocated to land titling and ownership enforcement are largely misallocated. While emerging scarcity and rising land values, determines the demand for ownership services, the supply of these services can be influenced by government and individual action which may either raise or lower their cost.

The relationship between land tenure, land values, and institutional development is extremely important when considering (market oriented) policies to influence land use decisions. In brief, if the policy lowers the value of land it weakens land tenure and local enforcement institutions. If it increases the value of land, the opposite is the case (see text).

Box III-2

abundance of land in the Amazon, this is very little. Were farmers also obliged to pay for (i) the loss of genetic material, (ii) the social costs resulting from global warming, and (iii) the marginal environmental damages imposed in its watershed,/86 there would be no "environmental" problem. If the value of food and fiber produced from the Amazon exceeded the value of resources used, including these "environmental" uses, then the farmer's decision to cut down forest to produce food would represent a socially beneficial decision. Since there is currently no mechanism for these environmental values to be expressed in the marketplace, however, the farmer who converts the forest to agricultural use ignores environmental consequences.

/86 For simplicity of expression, potential damages due to changes in the hydrology of the local and regional watersheds (including microclimatic changes) are included in the term watershed effects.

336. Ideally, therefore, public policy should attempt to create conditions in which those contemplating converting forest to other uses would face the full economic cost for the forest resource, including non-market "environmental" external costs. This can be done either through the introduction of "environmental taxes" at a level that reflects the estimated marginal environmental damage of the activity, or through the creation of an actual market mechanism. Ideally, both types of policies should be based on some type of environmental zoning. This will be discussed below, followed by an evaluation of the policies.

337. Environmental Zoning. The principle of environmental taxes or marketable environmental damage permits is that the social costs and benefits of an economic activity should be reflected fully in an individual's private production decisions. The application of this principle is complicated, however, by the fact that the environmental damage from the same activity varies with location and techniques. Deforestation may cause serious economic damage due to sedimentation of a dam in one location, for example, and pose no erosion problems in another. Similarly, some areas are rich in biodiversity and others may have little or no value from the point of view of species richness.

338. Ideally, one would like to price the environmental damage directly, not the activity generating the damage. Thus, in a world with no administrative costs, one would choose a species loss tax, a sediment tax, or a carbon dioxide tax, for example, rather than attempting to tax damages indirectly through taxing forest land conversion. As a practical matter, however, it is prohibitively expensive to measure and tax damages directly; the alternative is environmental taxes or marketable permits based on land-use activities likely to generate environmental damages, not directly on the damages themselves.

339. If individual behavior is to be changed through a tax (or environmental damage market) based on presumptive damages resulting from specific activities, some mechanism is needed to estimate the probability that the activity will actually lead to the damage. Thus, for example, if the damage is loss of species, the charges for felling trees in areas of high endemism should be higher than charges in areas where species endemism is low. If the damage is release of carbon dioxide to the environment, and species are redundant, tree harvesting would not be taxed, but tree burning would, and the tax (per square kilometer) would be differentiated on the basis of biomass density (carbon likely to be converted to gaseous form).

340. Environmental zoning can be used to translate activities into probable damages. This zoning would identify (reasonably) homogeneous areas on the basis of damage probability, and could be the basis of a system of damage taxes or damage permits. That is, areas would be defined so that, within a given area, the probable external damages imposed from a given activity are approximately equal.

341. Such environmental zoning should be concerned, to the maximum extent possible, only with the production of externalities, not with the production of marketable goods. The former is an appropriate concern for government intervention. The latter is generally better left to individual ingenuity.

342. Pollution Tax. An efficient operational environmental damage tax would require prior environmental damage zoning, as discussed above, to relate

the taxed activity to the consequent external damages. Fixing the level of the tax at the regional average marginal damage (per unit level of the activity) would approximate taxing the damage directly. There are three major problems with such a tax, however. First, in the best of circumstances, tax enforcement in the Amazon is extremely weak or nonexistent. Second (as will be discussed below), even if the tax were collectable from landowners in the Amazon, it would lead them to abandon their ownership to squatters. Third, such a tax provides no mechanism for the rest of the world to compensate Brazilians for reducing global externalities.

343. One fatal problem with a tax on Amazon forest burning at anything close to the current estimate of global damage is that it would likely lead landowners to relinquish ownership responsibility--compounding problems of property rights and enforcement. Consider the effect of a tax on land burning. The current best estimate of the present value of the (marginal) future global warming damages from burning a hectare of dense tropical forest is around US$2,200 per hectare. These damages substantially exceed the price of land on most of the Amazonian frontier, which currently varies from US$20 to US$300 per hectare, depending on access, quality of land, state of development or exploitation, and the quality of title.

344. If the price of land reflects potential use (after burning), a burning tax approximating burning's marginal cost to society would make land privately worthless./87 A landowner facing such a tax would find that the benefit of land ownership does not justify the costs. In the absence of alternative profitable uses of land, he would abandon his claim to title. The likely result over the long run would be that squatting would become the prevailing form of land tenure and enforcement of the burning tax could not be linked to land ownership. More generally, because the tax would weaken the local economic base, enforcement could not be expected to be enthusiastic at the local level.

345. Enforcement is, therefore, the key problem in attempting to maximize the social value of forest services by taxing externalities. It also plays a key role in balancing the costs and benefits of a given policy. An example will help to make the case. Assuming a discount rate of 10%, the annual net value of agricultural production on land worth US$300 per hectare can be estimated at

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/87 This assumes that, from the point of view of private profitability, the traditional pattern of logging, burning, agriculture, and livestock strongly dominates other uses of the land. If geographically stable agriculture or silviculture is only somewhat less profitable than techniques requiring burning, however, the value of land ownership may not be unduly affected, and the tax would have the desired effect of encouraging landowners to switch to more environmentally benign land uses.

US$30 per hectare per year.[88] An annuity corresponding to the (US$2,200) present value of global warming costs would be US$220 per hectare per year. Thus if enforcement costs exceeded US$190 per hectare per year, the total social costs (lost agricultural value plus enforcement costs) of reducing global warming through taxing forest burning would exceed the benefits.

346. Payments Not to Burn. The low value of land in the Amazon relative to the potential damage of burning clearly signals the potential for a trade between Brazil and the rest of the world. The enforcement problem could perhaps be overcome through a system of tradeable land-use rights. A much more straightforward mechanism would be to rent the land under medium-term leases. Either mechanism could be designed to (i) create incentives not to burn the forest; (ii) reinforce land ownership and owner responsibility; (iii) provide a direct mechanism for material expression of international concern over Amazonian environmental damages; and (iv) avoid possible problems of moral hazard.

347. The effect of a payment not to burn on land values and owner incentives can be illustrated from the above example. At the rate of discount of 10% assumed above a landowner should be indifferent between owning a hectare of land worth US$300 and an annuity of US$30 (because the present value of an income stream of US$30 forever is US$300). This suggests that the landowner could be made better off by paying him any value over US$30 not to burn. Unlike the case of taxation, where enforcement would be the burden of the public sector and would take place in a generally hostile local environment (increasing its costs and reducing its effectiveness), a subsidy not to burn would put landowners in the business of enforcement.

348. One mechanism to pay owners not to burn would be a scheme of Marketable Burning Permits.[89] Imagine an area of 100,000 km^2 that has been

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/88 In equilibrium land, labor, and financial markets (assumes certainty), the rental value of land should be equal to an annuity on the land price at the prevailing interest rate. Thus if the discount rate is 10%, the purchase price would be expected to be 10 times the rental value of the land. This relationship is theoretical, however, and can be distorted greatly by expectations based on factors other than the land's agricultural potential or the uncertainty of the actual duration of "ownership." For example, according to IGV data for the period 1984-87, the ratio of land values to rent in Mato Grosso varied from around 7 before the Bresser Plan to a high of 15 during the period of flight to real assets associated with the Bresser Plan, to 9.6 in the second semester of 1987. In Pará, which with its many large ranches may have felt somewhat more threatened than other Northern states by the possibility of land reform during the Constitutional debates of 1976-77, tne ratio of land prices to rental values fell from over 5 in 1984-85 to 3.4 in 1987.

/89 Currently, IBAMA issues permits to conduct slash and burn on abandoned farmland and pasture with the caveat that the half area must be registered in cartório and its permanent preservation recognized by heirs and successors. IBAMA levies heavy fines when unauthorized burning is documented.

determined to be of first priority for protecting biodiversity. Imagine also that the area is currently being burned at the rate of 1000 km^2 per year. A maximum of 3000 km^2 Marketable Burning Permits (MBPs) would be allocated to the landowners every three years (with an expiration date as of the subsequent auction) on a formula based on their land holding. Land burning could not take place without these permits, and they could be sold by the land owner to anyone who wanted to burn, or to prevent burning in the priority area. Thus if a NGO bought a landowner's allocation of MBPs, no burning could take place on that landowner's land for three years. If one landowner bought another landowner's allocation, he could burn an amount of land equal to the two allocations. This process would be repeated every three years. Enforcement under a tradeable scheme would require community cooperation, however, in providing assurances to preservationists that the rules of the scheme were being followed. Since landowners would be better off with the scheme than without it, the possibility for such cooperation exists. This would clearly need detailed analysis, however.

349. A simpler alternative would be for government, NGOs, and others interested in preservation to enter into medium-term rental contracts that allow the landowner to carry out limited activity consistent with the environmental objective. These contracts would explicitly make the landowner responsible for enforcement of environmental restrictions.

350. Renting land for preservation is more feasible than using Marketable Permits under prevailing conditions in the Amazon, and, if as argued above payment is required to make enforcement feasible, rental is the preferred option.

351. Under a rental system, short-term rental contacts would provide the owner with rapid feedback concerning the effect of his enforcement on the value of his future contracts. Similarly under a MBP system, contract violations would rapidly devalue future MBPs in the area and good enforcement would be rewarded.

352. Their restricted and short-term contracts means that neither scheme would be likely to be seen as a threat to Brazil's sovereignty, as would outright land purchases. NGOs, "debt for nature" arrangements, and other bilateral and multilateral organizations (such as the Global Environmental Facility) could participate either through a concerted strategic program or independent action.

353. A number of issues would have to be addressed. The major ones are (i) the treatment of public lands, (ii) moral hazard, (iii) minimum critical size of preserved areas, and (iv) the effect on local economies.

354. Public lands (and areas with poorly defined title) pose a special challenge for both schemes. Because property owners would be paid to restrict land use (and enforce compliance on squatters), pressures for illegal private use on public land could increase. Incentives for compliance and enforcement on public lands would have to be linked with those which exist for privately-held land. One mechanism would be to make the existence of the program contingent on some minimum level of participation of landholdings at the municipal level (say 50%), and agreed-upon conditions for protecting public lands. Participating municipalities might then be paid some fraction of the average bid (or rental) price for private land for each hectare of public land protected.

355. Potential moral hazard must be recognized and eliminated. It is conceivable, for example, that the program could create incentives to build a

road to an area zoned as rich in biodiversity, solely for purposes of increasing the threat to the area. Similarly, it is possible that the program could create incentives for land concentration in order to gain market power in the selling of MBPs.

356. A minimum critical size of contiguous protected area is essential for protecting biodiversity. This suggests that the auction should contain a mechanism allowing contiguous land-use rights to receive a higher value than those that are isolated.

357. If successful, the program would probably lead to pressure to clarify land titles and, perhaps, in some areas, to an increase in land concentration. This process is likely to reduce the prospects for squatters and small farmers./90 Hence, the potential policy conflict between land reform in the Amazon and land preservation must be faced squarely.

358. Similarly, a successful program would depress the local economy and create pressures for depopulation, much as occurred in the American midwest under the soil bank set-aside programs of the 1960s. Although, from an environmental and overall social point of view, this would be a positive outcome, it would doubtless create local social dislocations.

D. Areas for Future Research

359. Five important areas for future research have emerged in the preparation of this report. These are:

(a) how to operationalize international transfers to obtain efficient greenhouse gas reductions;

(b) the role of unsustainable harvesting (mining) from native forests in the international timber market;

(c) the supply and demand for land tenure services and its relationship to natural resource degradation;

(d) the phasing of government services in a frontier economy; and

(e) how to operationalize decision rules for dealing with the environmental impacts of roads.

These are elaborated below.

360. Efficient Mechanisms to Achieve Greenhouse Gas Reductions Considerable work has been done in the area of comparative analysis of the worldwide costs of greenhouse gas reductions (Nordhaus, op. cit., Barbier et al, 1990). Much work is also currently underway within the context of the Global

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/90 It is possible that extractivists, unlike farmers, could benefit. Extractivists, whose meager income has typically not made it possible to compete with farmers and ranchers for land, could now operate under the cover of the landowners contract not to burn, perhaps in exchange for enforcing the burning prohibition on squatters and other invaders.

Environmental Facility to develop mechanisms to efficiently channel resources to reduce negative global externalities. Within industrial countries the "polluter pays" principle seems to be well accepted, on both equity and efficiency grounds. As demonstrated in this report, under certain conditions, enforcement costs under "polluter pays" can be prohibitive, especially where government is weak. This report has discussed the pros and cons of various schemes to use global transfers to achieve low cost greenhouse gas reductions in the Amazon. Considerably more work is required to make such schemes fully operational, however.

361. The Role of Native Forests in The International Timber Market. As a generalization, it is probably true that the price of timber on both domestic and international markets is determined by the costs of unregulated producers in native forest. If so, it follows that regulating some firms (or countries) without similar regulations on all players in the industry, will put the former at a competitive disadvantage. Recognizing this problem, the ITTO has proposed "green labeling" of timber harvested in a sustainable manner, with the expectation that timber not so labeled would be denied access by many countries.

362. The availability of natural forest has important implications for reforestation and plantation forestry. Does it make sense, for example, to propose commercial planting in areas where native forest is still vast? Clearly, with the exception of wood with characteristics not found in native species (long fiber pulp wood, for example) or areas far from natural forest, it will be cheaper to harvest from native forests than to tie up land and capital waiting for plantations to reach maturity--especially in countries with high interest rates.

363. Two policy alternatives are possible to take pressure off the natural forest. First, logging from native forest could be tightly regulated. The industry impact would be to reduce the competitiveness of the domestic wood and wood products industry both domestically (against imports and/or substitute materials) and internationally. Second, plantation forestry could be subsidized to make it more competitive than natural forest. Subsidies for plantation forests are very common worldwide./91 Although it may be possible to justify subsidies for plantations on the basis of external benefits, it is difficult to see how rational policy would combine weak protection for the natural forest with high subsidy rates for plantations.

364. The importance of the price depressing effect of the existence of natural forest to any country (or market within a country) hinges critically on the contestability of that market from wood from natural forest. This, in turn depends on the substitutability of wood from various sources within markets, and the trade policies of the countries. This is an extremely important issue for Bank forestry policy. A study currently in its initial stages will explore first, the accuracy of the above generalizations concerning the role of native forest in determining the world's market price. Second, it will look at the substitutability among various types of wood within the individual countries in the Amazon basin, and the implications for wood products policy.

/91 Importantly, plantation forests often grow long fiber pine to complement rather than substitute natural forest wood. Subsidizing the long fiber pine plantation therefore increases rather than decreases demand for the native (complementary) wood.

365. Land Tenure and the Environment. Box III-2 discussed the relationship between land scarcity and choice of economic activity. The basic point is that, at the economic frontier, land tenure relationships are weak because with land sufficiently abundant, the absence of economic rent makes it unprofitable to invest in land ownership and protection. It is difficult to distinguish, on the other hand, this case from one where economic rent does exist, but institutional barriers prevent the emergence of land tenure services (titling and property rights enforcement), not lack of demand. In both cases, economic actors (farmers, loggers, ranchers) will tend to mine the resource--in the first case because land abundance makes new land cheaper than fertilizers and pesticides, and in the second because without the ability to exclude others, no one has an incentive to invest in the future productivity of the resource. This suggests that to properly diagnose the cause of the land degradation, analysis must be focused on both the supply and demand for land tenure services.

366. The inability to distinguish easily between lack of scarcity and problems of land tenure institutions creates problems for Bank project design. For example, a land tenure improvement project at the economic frontier, intended to encourage land stewardship, may well improve ownership institutions, but not alter stewardship. With land sufficiently abundant (and cheap), investment in land conservation and fertility may not pay, whether or not the land is securely owned.

367. A closely related issue is that of the relationship between signalling ownership, and environmentally destructive activities. At the economic frontier, open access land may generally be claimed by investing resources in signalling to others one's intent to put the land to economic use. This typically requires clearing boundary zones or some other form of permanent marking of the land. As pressure on the land increases, it is no longer sufficient to mark the land, but it now becomes necessary to monitor whether or not the land is being invaded. In forest areas, this is greatly facilitated if the land is cleared of trees, which both improves visibility, and increases the prospective owner's presumptive claim to the future use of the land. The land resource may be degraded somewhat in the process, but from the standpoint of the settler, this degradation of the resource is part of the price of obtaining ownership.

368. Degrading the resources is one way that economic rent becomes dissipated in order to establish ownership. The range of circumstance in which economic behavior, or the land resource itself, is altered in order to influence ownership probabilities is varied and rich. For example, in Paragominas (Brazil) farmers who had clearly established ownership were more likely to deforest for industrial charcoal than were those who were still awaiting completion of titling. The reason was that those who had not yet received clear title from the land agency feared that participating in the charcoal program might prejudice their claim to title--they were willing to forego the profits from the program to increase their claim to title. Interestingly in Botswana, farmers without clear title were found to be more likely to plant perennial treecrops than those with clear title--again contrary to the conventional wisdom--essentially to influence their claim to title. Similarly, throughout the Cordilleras, one observes deforestation and low intensity but very erosive cattle ranching as a means of signalling land ownership.

369. All of these examples represent costs that people are willing to pay in order to establish land ownership. Recognizing the commonality among them opens up an extremely rich research agenda with important policy implications. For example, would the problem of burning to establish ownership be best dealt with through clearer titling, better government enforcement of both legal and squatting rights,/92 improved credit policies (for example, to allow non-title holders to buy barbed wire and/or hire private law enforcement, or alternative, innovative forms of signalling? In sum, how can the Government minimize the costs of obtaining and enforcing land ownership--whether the cost be in terms of resource degradation, opportunity cost, or public and/or private enforcement?

370. Phasing of Government Services at the Frontier. The issue of the phasing of government services is closely related to that of land rent and land tenure services discussed above. Essentially the problem is how to determine the appropriate level of government services in an area with an extremely weak local economy. The case of land titling and enforcement institutions discussed above is a good example. Should the Government be willing to pay, say $50 per hectare to protect private property when the value added of the land (excluding government services) is only $40 per hectare? Clearly putting the $50 into other government investments or services would pay a higher return in terms of economic growth.

371. As discussed, government is already very expensive in much of the Amazon relative to regional value added. Yet the provision of government services is of a relatively low standard. Nation-building requires some homogeneity of institutions and services. Is the answer to spend more? Increasing the regional subsidy would almost certainly reduce Brazil's overall rate of growth and employment creation. It would also increase the secondary impacts of increased incomes on the Amazon, mainly increased demand for agricultural land in the forest. Reducing government services, on the other hand, would result in the standard of government at the frontier falling even further behind that of the rest of the country.

372. While it does not make sense to recommend identical quality government services throughout the country, neither does it make sense to suggest, for example, that the ratio of regional government expenditure to regional value added be constant throughout the country. One approach would be to look for a trajectory relative to economic base that would have government services and institutions in some sense heading to the same target, if not currently at the same level. What, exactly, this means is an area for further work.

373. Decision Rules for Roads Construction. This report has discussed a number of general principles which would aid in the rational planning and construction of roads. These rules have involved (1) whether or not to build a road, (2) how to balance the national and global interest in new road construction, and (3) how to make new road projects consistent with existing or planned reserves policy. Considerably more thought will be required to operationalize these principles. In view of the pace of construction of roads in certain Amazon Basin countries (especially Bolivia), this work is of the highest priority.

/92 Squatting rights are recognized in the law of most countries.

E. Summary and Conclusions

374. As a general principle, environmental policy in the Amazon should focus on specific environmental problems to be resolved or prevented--not on general indicators of land use conversion. The long-run objective of environmental and land use policy should be to maximize the social benefits of land use decisions. Because the value of external environmental costs in the Amazon is high while the private benefits are low, this principle would generally lead to land being left without development. Translating this principle into policy is a difficult challenge, however, as knowledge is limited and there are practical difficulties for enforcement.

375. Brazil's Amazon strategy requires action in three areas--forest access, policy distortions, and preservation of special areas. These are summarized in Table III-3. First, any future access into the Amazon must be clearly and convincingly demonstrated to be in Brazil's best interest and Brazil should permit the rest of the world to compensate Brazil for the introduction of alternatives which would provide the same benefits to Brazil at a lower cost to the rest of the world. Second, policy distortions should be removed that create artificial incentives to convert forest to other uses. Finally, the possible role of market-oriented mechanisms in preventing socially harmful forest conversion should be explored. Of the major candidates, a burning tax, marketable burning permits, and outright land rental (for preservation) with the owner being responsible for preservation, appear to offer the best potential. The problem of control on public lands may require more complicated solutions, however, which provide local incentives to prevent encroachment.

376. Reserve lands (indigenous, extractive, and biological) should be clearly delineated, titled and protected. Reducing the insecurity of land tenure would in general reduce the incentive to "signal" the ownership of land through burning and occupation. Over the long run, improving the security of land title will reduce deforestation only if agricultural packages can be developed that make stable agriculture competitive with nutrient mining. For much of the frontier there is no economic rent to land to stimulate the emergence of property rights. In any event, the current confusion over federal, state, and local prerogatives with respect to land policy should be eliminated.

Table III-3: SUMMARY EVALUATION OF POLICIES TO REDUCE ENVIRONMENTAL EXTERNALITIES IN THE AMAZON

Policy Area	Medium-term Objectives	Measures Taken	Possible Additional Measures	Comments
Control Forest Access	Maximize the net global benefits of any new transport infrastructure in the Amazon. Compensate for any losses this might entail for Brazil.	None.	• Improve Cost-Benefit analysis of future proposed infrastructure projects to include all calculable Brazilian and Global externalities or a range of alternatives. • Choose project with highest Global net benefits and compensate Brazil for any losses relative to the Brazilian social optimal project.	Constitutional reform has given lower levels of government more fiscal autonomy (at the federal government's expense). Future pressure for infrastructure development is likely to come from states and municipalities, not the federal level.
Eliminate Policy Induced Distortions	Eliminate distortions that "pull" immigrants into the Amazon.	• Funding for commodity price supports and subsidized credit has been reduced dramatically. • Subsidized investment to new cattle ranches has been restricted.	• Eliminate funding for programs in previous column. • Eliminate uniform fuel pricing. • Eliminate tax policies that favor agriculture and ranching. • Eliminate regional fiscal incentives. • Eliminate incentives federal revenue sharing schemes for states and municipalities to encourage population growth.	• The minimum price program has the most important potential environmental effect. • The environmental effect of the uniform price policy is locally important, but may be either positive or negative. • Tax policies and subsidies to investment are probably relatively unimportant because of weak enforcement and strong incentives to divert funds to more profitable uses (e.g., the overnight market).
	Eliminate distortions that "push" emigrants from outside the Amazon.	Tax shelters favoring large farms have been reduced under the Collor plan.	• Eliminate policies tending to favor large farms and displace rural labor from other states (e.g., ethanol subsidies, agricultural tax shelters, differential access to commodity price supports and subsidized credit).	The rate of migration is slowing, due in part to the relative lack of success of previous migrants and the stabilization of the pool of potential new rural migrants. The rate of natural increase within the Amazon remains high, however.
	Reduce incentives for environmentally and economically wasteful "signaling" of land occupancy and/or ownership.	Burning of land is no longer accepted as proof of occupancy for purposes of obtaining land title.	Clarify the authority of the state, federal, and municipal governments with respect to land policy.	The low and temporary productivity of most Amazon soils may not support the emergence (or justify the creation) of institutions to establish and defend property rights. Current biological and indigenous reserves should receive top priority for delineation and enforcement.

Table III-3: SUMMARY EVALUATION OF POLICIES TO REDUCE ENVIRONMENTAL EXTERNALITIES IN THE AMAZON (cont'd.)

Policy Area	Medium-term Objectives	Measures Taken	Possible Additional Measures	Comments
Preserve Special Areas	Protect indigenous groups and biological and extractive reserves.	Over one fifth of the Amazon has been designated as either a park or a reserve.	• Develop and implement a biodiversity protection plan; designate priority areas to be protected. • Ensure that new infrastructure does not increase incentives for illegal activity in reserves and parks. • Develop buffer zones around parks and reserve areas; create incentives for local enforcement of zoning regulations. • Explore market-based mechanisms to protect selected areas, e.g., land rental, taxes, or marketable land-use permits.	• Cloudy land tenure arrangements currently combine with weak local institutions to make local enforcement of reserve and park policy impossible. These weaknesses are exacerbated by taxes or restrictions which would slow the demand for land ownership and erode the local economy.
Explore Market-Based Mechanisms	Bring landowners and others to consider social costs in their private decisions.	None	Tax the external (social) damages. Consider a system of marketable burning permits. Consider renting land with owners responsible for preservation.	Probably not feasible to implement in the Amazon. If enforceable, effective taxation of burning at marginal global warming costs would end burning for agriculture in the Amazon. Implementation of marketable burning rights, with an allocation that did not make landowners worse off, would be more feasible than a tax--but is still probably not a realistic option. • Current land values and rental rates suggest that landowners could be paid enough to be made better off than they are currently, while still making Amazonian carbon sequestering cheap relative to controlling greenhouse gas emissions from other sources. • Incentives would have tao be found to give the local community a stake in preventing encroachment on public lands.

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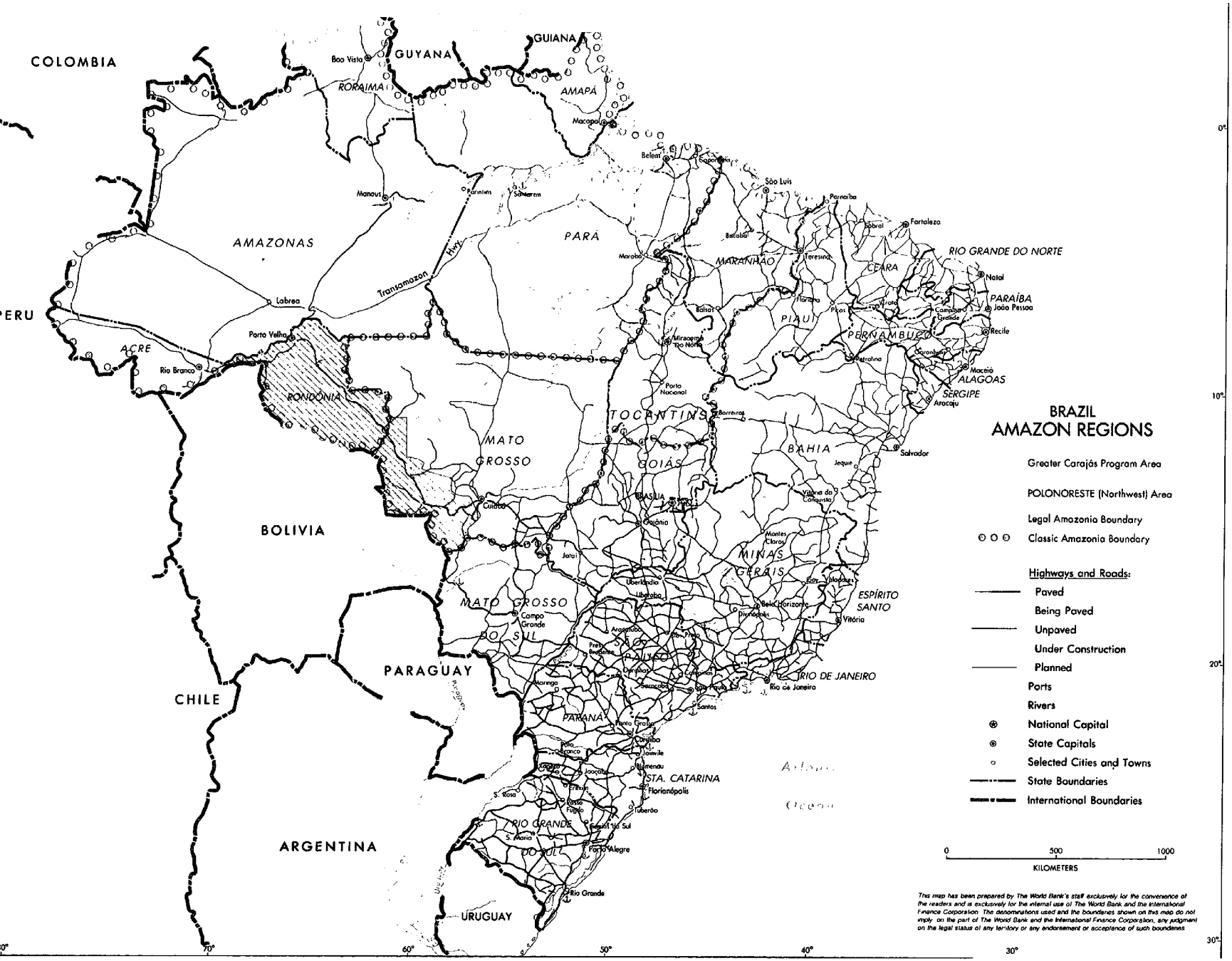


BRAZIL
AMAZON REGIONS

Greater Carajás Program Area

POLONORESTE (Northwest) Area

Legal Amazonia Boundary

Classic Amazonia Boundary

Highways and Roads:

- Paved
- Being Paved
- Unpaved
- Under Construction
- Planned

Ports

Rivers

National Capital

State Capitals

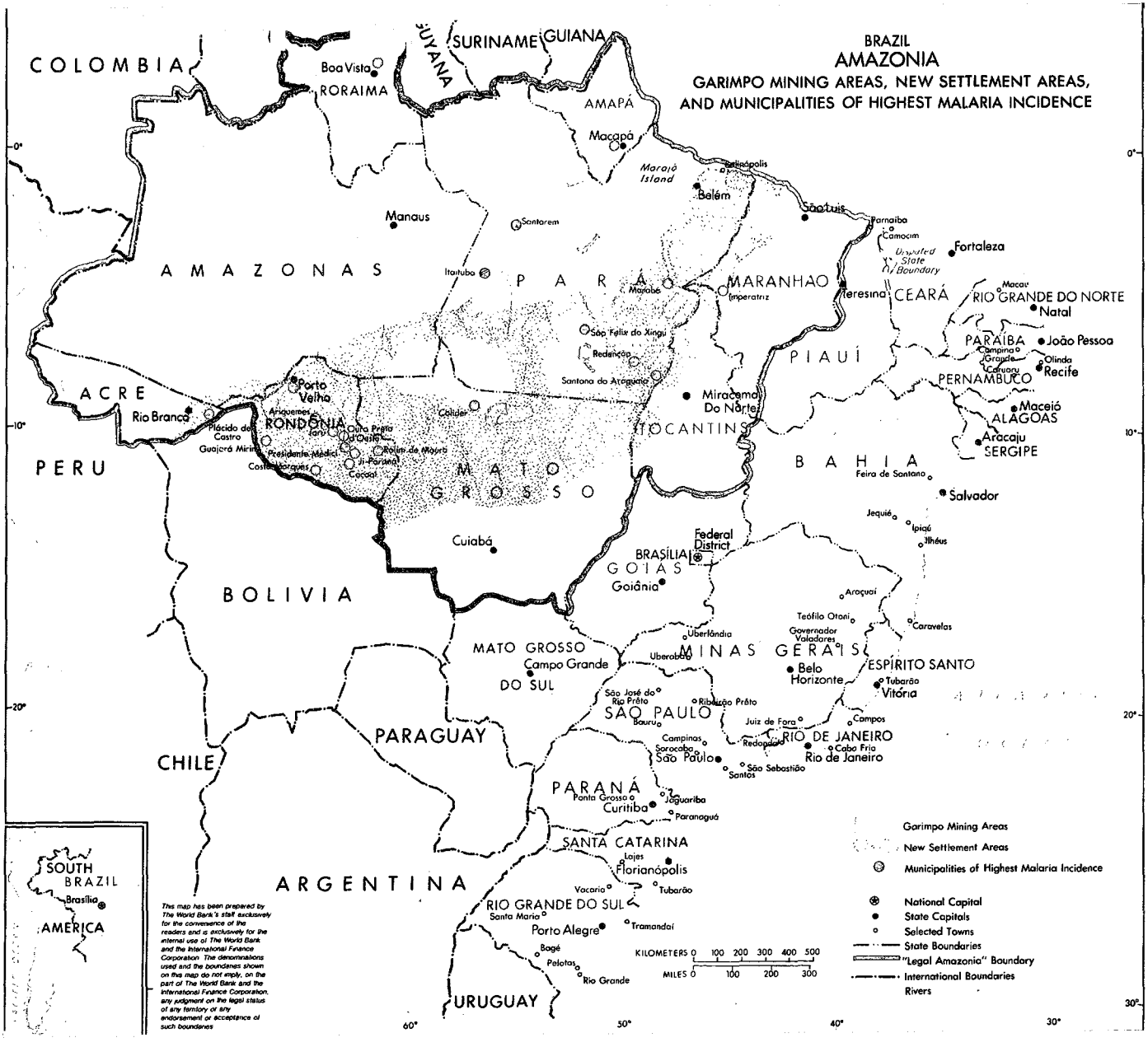
Selected Cities and Towns

State Boundaries

International Boundaries

0 500 1000

KILOMETERS


BRAZIL
AMAZONIA
GARIMPO MINING AREAS, NEW SETTLEMENT AREAS, AND MUNICIPALITIES OF HIGHEST MALARIA INCIDENCE
COLOMBIA
SURINAME
GUIANA
GUYANA
Boa Vista
RORAIMA
AMAPÁ
Macapá
Marajó Island
Belém
São Luís
Parnaíba
Camocim
Fortaleza
Disputed State / Boundary
AMAZONAS
Manaus
Santarem
Itaituba
PARÁ
Marabá
MARANHÃO
Imperatriz
Teresina
CEARÁ
RIO GRANDE DO NORTE
Natal
PARAÍBA
João Pessoa
Campina Grande
Caruaru
Olinda
Recife
PERNAMBUCO
São Felix do Xingu
Redenção
Santana do Araguaia
PIAUÍ
Miracema do Norte
Maceió
ALAGOAS
Aracaju
SERGIPE
ACRE
Rio Branco
Porto Velho
Ariquemes
Ji-Paraná
Cacoal
Colider
Costa Marques
Guajará Mirim
Plácido de Castro
Presidente Médici
Pimenta Bueno
Vilhena
RONDÔNIA
TOCANTINS
MATO GROSSO
BAHIA
Feira de Santana
Salvador
Jequié
Ipiaú
Ilhéus
PERU
Cuiabá
Federal District
BRASÍLIA
GOIAS
Goiânia
BOLIVIA
Araçuaí
Teófilo Otoni
Governador Valadares
Caravelas
Uberlândia
Uberaba
MINAS GERAIS
Belo Horizonte
ESPÍRITO SANTO
Tubarão
Vitória
MATO GROSSO DO SUL
Campo Grande
São José do Rio Prêto
Ribeirão Prêto
SÃO PAULO
Bauru
Juiz de Fora
Campos
RIO DE JANEIRO
Redenção
Cabo Frio
Rio de Janeiro
Campinas
Sorocaba
São Paulo
Santos
São Sebastião
PARAGUAY
CHILE
PARANÁ
Ponta Grossa
Curitiba
Jaguariaiva
Paranaguá
SANTA CATARINA
Lajes
Florianópolis
Vacaria
Tubarão
ARGENTINA
RIO GRANDE DO SUL
Santa Maria
Porto Alegre
Tramandaí
Bagé
Pelotas
Rio Grande
URUGUAY
SOUTH AMERICA
Brasília
Garimpo Mining Areas
New Settlement Areas
Municipalities of Highest Malaria Incidence
National Capital
State Capitals
Selected Towns
State Boundaries
"Legal Amazonia" Boundary
International Boundaries
Rivers
KILOMETERS 0 100 200 300 400 500
MILES 0 100 200 300
0°
10°
20°
30°
60°
50°
40°
30°
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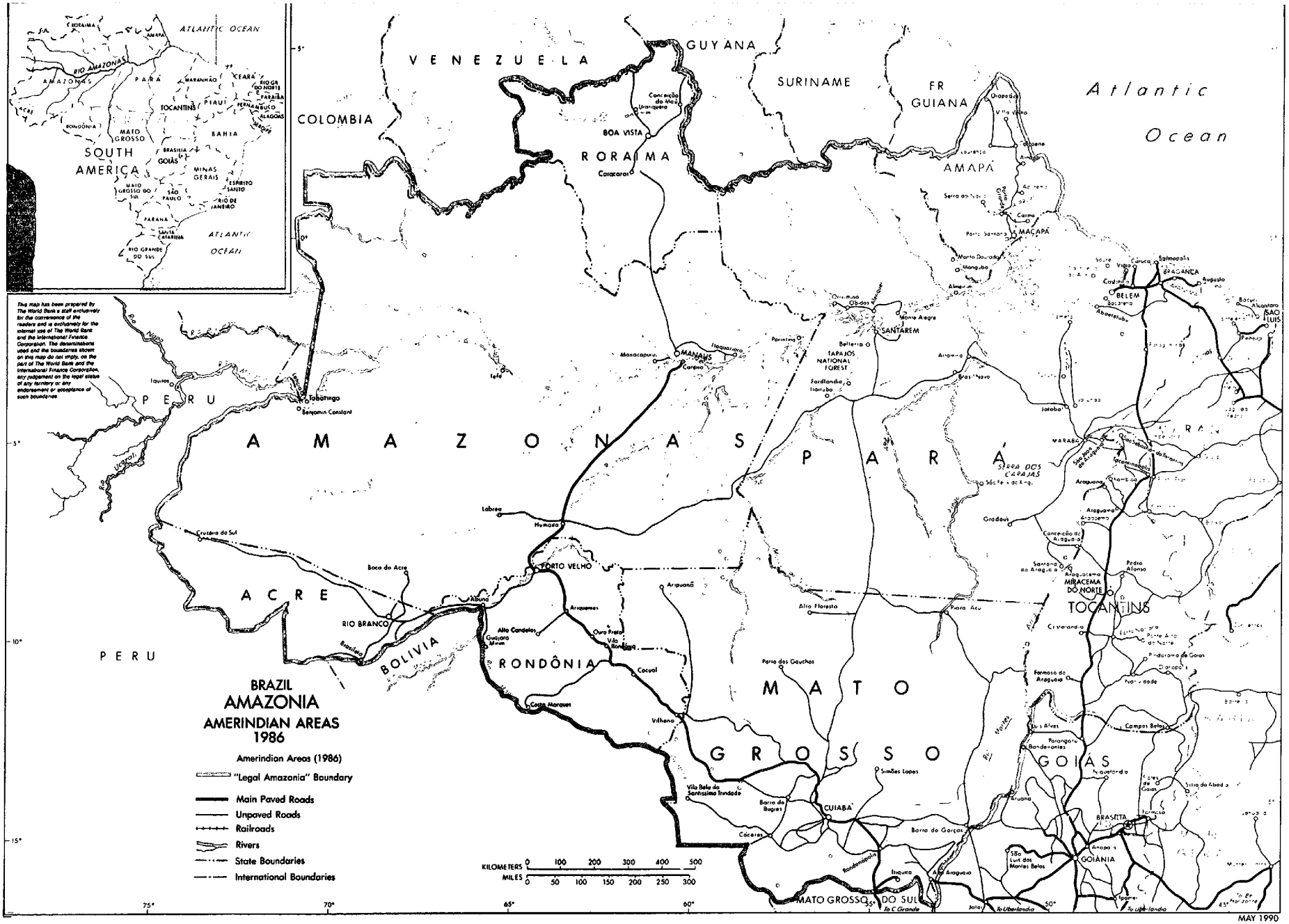
BRAZIL
AMAZONIA
AMERINDIAN AREAS
1986
Amerindian Areas (1986)
"Legal Amazonia" Boundary
Main Paved Roads
Unpaved Roads
Railroads
Rivers
State Boundaries
International Boundaries
KILOMETERS 0 100 200 300 400 500
MILES 0 50 100 150 200 250 300
VENEZUELA
GUYANA
SURINAME
FR GUIANA
COLOMBIA
PERU
BOLIVIA
Atlantic Ocean
BOA VISTA
RORAIMA
AMAPÁ
MACAPÁ
AMAZONAS
PARÁ
ACRE
RONDÔNIA
MATO GROSSO
TOCANTINS
GOIÁS
MARANHÃO
MANAUS
SANTAREM
BELEM
SÃO LUIS
PORTO VELHO
RIO BRANCO
CUIABA
GOIÂNIA
BRASILIA
SOUTH AMERICA
MAY 1990