

BRAZILIAN DEVELOPMENT AND DEFORESTATION OF AMAZONIA: AN ENVIRONMENTAL VALUATION APPROACH

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ABSTRACT: *This paper examines Brazilian government development decisions and how they relate to the forces and issues behind the current trend of deforestation in Brazilian Amazonia. More specifically, the paper focuses on the adverse side effects of development and deforestation within an environmental valuation context. Issues surrounding preservation and conservation of Amazonian resources will be explored, and the concepts of uncertainty, irreversibility, and option value introduced and discussed as they apply to development policy decision making. In many cases, development activities that modify the natural environment would not be undertaken if the potential future benefits of the undisturbed forest were considered in the development decision. Conclusions will be drawn concerning appropriate and responsible development of Amazonia compatible with retaining the natural environment.*

INTRODUCTION

The Amazon region of Brazil, the largest area of tropical rainforest on earth (Figure 1), is presently the site of one of the great discontinuities in human history -- the irrevocable replacement of a major biome (ecological community) with agricultural systems. The Amazon has a history of exploitation under various modes of extraction, but none as destructive, or extensive as those currently in practice and aided by the use of modern day capital and technology.

Over the past three decades, the Amazon has been increasingly affected by the Brazilian national government programs for rapid industrialization and for integration of the country. Brazil's reliance on international capital for rapid industrialization caused a large increase in foreign indebtedness. The Amazon came to represent a great reserve of natural resources to government planners who were searching for ways to pay for the influx of industrial capital. Unfortunately, the development process has taken on an increasingly destructive form, in which social exploitation has been directly associated with irreversible ecological destruction (Binswanger, 1991).

Whether Brazilian policy makers acknowledge it or not, the rest of the world has a legitimate interest in what happens to Amazonia. The medical secrets locked in its plants may cure the sick of many countries; and the genes of its wild plants may reinvigorate crops that feed billions of people. Environmentally, the destruction of the Amazon has a double impact on the carbon accumulating in the earth's atmosphere as growing trees lock up carbon and burning or rotting trees release it. Brazil's own climatologists now believe that the burning Amazon accounts for up to 25% of global carbon-dioxide emissions. Many scientists think that atmospheric carbon dioxide is disastrously causing the earth to warm up (UNEP, 1997).

Brazil itself, as the press and even its own government have begun to realize, has a powerful interest of its own in preserving its treasure. A growing body of evidence, much of it collected by Brazilian scientists, suggests that forests feed rainfall, as well as absorbing it. Cut the trees down, and nearby regions suffer higher temperature and more drought. The destruction of Africa's jungles may well have caused the Sahara to advance; destroy the Amazon, and large tracts of central and northern Brazil might suffer the same fate (UNEP, 1997). Central planners who support a resource exploitation

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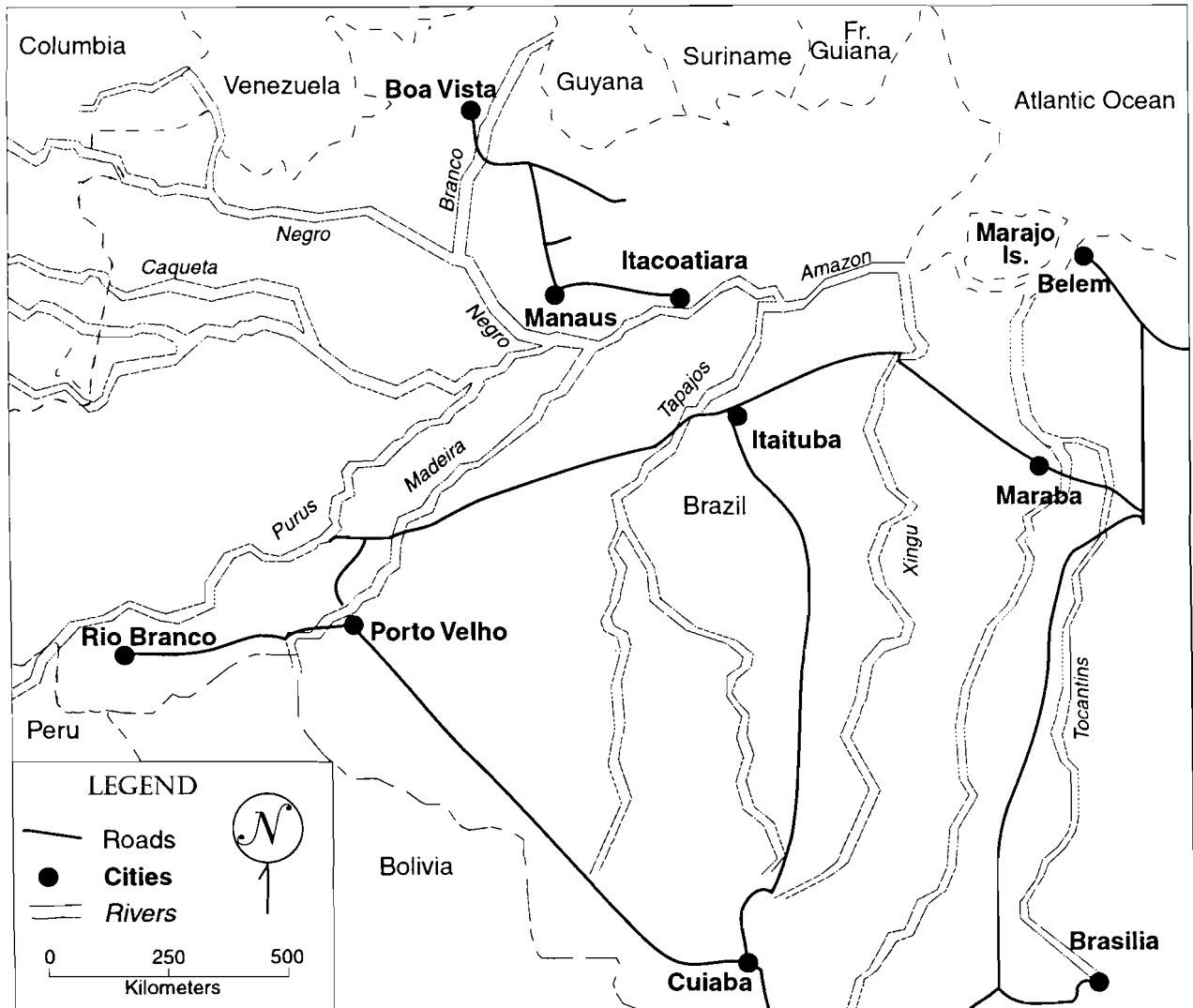


Figure 1: The Brazilian Amazon Basin, including some of the principal urban centers and highways.

development strategy for the Brazilian Amazon have argued that the present situation is early stage. Waste, chaos, and failures of many sorts are normal in frontier settlement. With greater investment of labor and capital and development of appropriate farming systems, the economy and land use will stabilize (Moffett and Fritsch, 1999; Coomes, 1995; Alston et al., 1995).

Those against development in Amazonia, particularly current agricultural development efforts,

argue that central planning authorities, utilizing a resources exploitation strategy that focuses solely on increases in output, are recklessly promoting expansion regardless of profitability. Past development of Amazonia, they argue, has been fueled almost entirely by government subsidies and land speculation, and has produced no economic gain. Amazonian soils are inherently fragile and cannot sustain productive agriculture or pasture, and in almost all cases deforestation has led to severe soil

degradation and irreversible ecological damage (UNEP, 1997; Hecht, 1992).

Other groups favor development, but only if it is restricted to appropriate sites and done by colonists who use appropriate cultivation techniques. This group maintains that there is considerable variation in Amazonian soils, and that agricultural production is more easily sustained in zones that are ecologically more suitable for continuous cultivation. Thus, farmers who adjust cultivation practices to compensate ecological realities can sustain continuous cultivation and/or productive and nondamaging crop rotation systems, even on poor Amazonian soils (Wood and Walker, 1999; Smith, 1999; Rice et al., 1997; Coomes, 1995).

Broken into three subsections, the paper will examine the adverse side effects of development linked to deforestation over the last three decades, and why, in many cases, environmental degradation has occurred. In the first section, Brazilian development strategies for Amazonia will be overviewed, including motivation and subsequent land use implications. In the second section, issues surrounding preservation and conservation of Amazonian resources will be explored within an environmental valuation context, and the concepts of uncertainty, irreversibility, and option value introduced and incorporated into discussion regarding potential future benefits of the undisturbed tropical forest, and their needed role in development policy decision making.

In the last section, conclusions will be drawn concerning appropriate and responsible development of Amazonia compatible with retaining the natural environment. Important elements of responsible natural resources policy will be outlined within an environmental valuation framework, followed by a discussion of specific policy reforms that are beginning to be implemented with some success.

BACKGROUND: BRAZILIAN DEVELOPMENT STRATEGIES, MOTIVATION, AND LAND USE IMPLICATIONS

Because of discontinuity in planned development efforts by successive military and civilian government administrations, especially over the last thirty years, it is hard to categorize Brazilian government development strategies for Amazonia within a specific set of clearly stated development policies (Lozada, 1999; Godfrey, 1999; Schneider, 1996; Burns, 1993; Inter-American Development Bank, 1985-1997). In broad terms, however, current Brazilian development policy would seem to fall into a general resource exploitation development strategy based on elements of a Frontier Economy of superabundant natural resources, similar to Brazil's extractive export-oriented development strategies of the past. In a Frontier Economy model, Amazonian resources are assumed to be so abundant (endless) that natural resources commodity production can always be expanded in proportion to the labor-capital inputs applied. Even though current Brazilian plans aim at integration of the isolated Amazon with the rest of the nation, it is questionable whether or not the policies under this strategy are any different from earlier ones which emphasized export of natural resources to the disadvantage of renewable resource development, in particular agricultural development. To keep up with growth in demand for agricultural products, for example, Brazilian strategy has been to increase the area under cultivation, rather than to increase yields per hectare. The resource exploitation strategy is relevant where lands are still available for pioneer settlement or plantation development, but as Yujiro Hayami and Vernon W. Ruttan note, "The resource exploitation development strategy provides little insight into the problem of how to generate growth in land and labor productivity when the slack resulting from underutilized natural resources has been exhausted" (Hayami and Ruttan, 1985:45).

The effort to develop Amazonia, however, should be viewed as a continuation of earlier Brazilian government efforts to develop the interior (Figure 1), such as the construction of a new national capital at Brasilia (1956-1960), and the building of the Belem-Brasilia Highway (1957-1960), followed

in 1966 by transformation of the old Rubber Bank into the Banco da Amazonia (BASA), and formation of the Manaus Free Trade Zone (SUFRAMA) in 1967. Not until 1970, however, did the great push begin with the announcement of the National Integration Program (PIN) and the building of the Transamazonian Highway (Burns, 1993; Sternberg, 1995; Godfrey, 1999).

Development of the Amazon began with a clear social agenda in mind – the settlement of poor landless peasants. However, over time, political maneuvering by powerful entrenched interests eventually managed to get policy orientation redirected away from small farmer colonization to large-scale cattle ranching, and industrialized exploitation of natural resources. The change in focus of promotional efforts has important implications for speed and types of development and deforestation under the resources exploitation development strategy.

Furthermore, much of the settlement of Amazonia today, as in the past, is done with no government or other planning whatsoever. The majority of migrants are dispossessed peasants from other regions, especially the Northeast, where mechanization and capitalization of agriculture has disrupted traditional forms of land tenure and created a growing rural landless class (Burns, 1993; Browder and Godfrey, 1996). Most rural settlement continues to occur outside colonization areas, on private or public lands. Unplanned colonization by squatters, the traditional means of settlement, has led to many fights over legal ownership of the land. Many times land that is cleared by small farmers without documents is later taken over by large ranchers. The expulsion of settlers already on the land is almost always violent, particularly as settlers become conscious of the fact that they can find strength in unity. Rarely does the process seem to work in reverse, with absentee investors losing to squatters land they had bought (Burns, 1993; Browder and Godfrey, 1996; Schneider, 1996).

Furthermore, the effect of peasants' annual crops on the natural environment has been minor in comparison to the destruction wrought by massive clearing for cattle ranches. Hecht and others have argued that, for a variety of reasons, ranching is a relatively unstable and unproductive land use for the region, particularly since it causes high ecosystem losses and creates only short-term profits and low

employment potential (Hecht, 1992). However, for large corporations and wealthy Brazilian investors from urban areas in southern Brazil, particularly land speculators, cattle ranching is relatively easy to initiate compared with other agricultural options in the region, such as pepper, cacao, and rubber plantations because it has low labor requirements and is easy to maintain. Clearing land and planting pasture is also a method of maintaining claim to land and qualifying for a definitive title. Thus, as Hecht notes, the enormous speculative gains irrespective of productivity and/or sustainability, provides little incentive for the development of careful management techniques and serves only to exacerbate the stability of existing pastures. Despite the problems outlined, however, cattle ranching continues to be, by far the most widespread use of land in Brazilian Amazonia (Hecht, 1992).

The second most widespread use of land to evolve from the resource exploitation development policies is mining, and increasingly, hydroelectric energy production. Government planning officials argue that the economic return from mining and hydroelectric energy production projects is worth the environmental cost involved. Heavily dependent on imported oil, Brazil requires further massive amounts of hard currency to service a large and growing foreign debt, as well as meet the ever increasing power needs of the rapidly growing population and industrial economy. These obligations have compelled Brazil to press hard to achieve rising levels of exports from all possible sources, as well as initiate construction of several large hydroelectric projects.

Interestingly, relative to other forms of development, mining, as well as hydroelectric energy production, apparently will not do great ecological harm to the basin. Sternberg (1997b) notes that hydroelectric development in particular is one of the most appropriate forms of development that is generally compatible with the environment of Amazonia, and that the benefits associated with development are worth environmental costs. Even critics of mining generally, agree that the ecological and demographic disruption caused by mining is small in comparison to that caused by the extension of new roads and by the lumbering and ranching which have followed them throughout the development of Amazonia. Mining and hydroelectric activities are generally restricted to relatively small

areas, and their location depends on geological accident far more than on proximity to roads (Sternberg, 1997a; 1997b; 1995).

PRESERVATION AND CONSERVATION OF THE BRAZILIAN AMAZON

Generally focused solely on increasing output, particularly of agricultural commodities, the resource exploitation policies in place do not take into account the value of services provided directly by the standing tropical forest. The economics of preservation and conservation of natural areas involves two key concepts: uncertainty and irreversibility. Uncertainty, because the possibly substantial future benefits of as yet undiscovered species and biological systems in the Brazilian Amazon are unknown. Irreversibility, because the extinction or loss of species and biological systems are indeed irreversible, and in most cases the consequences are impossible to ameliorate. In addition, the concept of "option value" will be introduced, and along with uncertainty and irreversibility, used to clarify the current concerns surrounding preservation and conservation in the Brazilian Amazon (Tietenberg, 1996; Howe, 1994; Turner et al., 1993; Pearce, 1993; Fisher and Krutilla, 1985).

The natural area component of the Brazilian Amazon deserves special attention for two reasons: (1) preservation of plant and animal populations contribute to human welfare by conserving genetic information that may in the future be useful in some form of economic activity, and (2) as components of living ecosystems that provide the basic physical and biological supports for human life (Pearce and Moran, 1994). With regards to the first, many of the known and unknown species of organisms in the Amazon offer significant, albeit uncertain, potential for utilization by humans. Brazil, with over a third of the world's moist tropical forest, contains at least 40% of the estimated 4.5 million plant and animal species in the world (UNEP, 1997). Only about 20% of these have been catalogued and an even smaller proportion of the catalogued species has been screened for their potential value. Of those plants that

have been studied, some have been used in drugs to treat heart disorders and various forms of cancer. Scientists have not yet been able to synthesize many of the natural ingredients in these drugs (Pearce and Moran, 1994).

Other wild plants found in forested regions have been modified to produce some of the staples of both tropical and temperate diets, such as yams and some legumes. In addition some wild tropical varieties are bred with either tropical or temperate zone crops against disease and pests. In the future, yet other tropical plants might prove to be valuable sources of food in temperate regions (Smith, 1999).

However, rain forests because of their great diversity of species are very sensitive to disruption of their habitat. Destruction of even a few square miles of Amazonian forest may bring extinction to some variety of trees, plants and a whole spectrum of other biological species. Their unique genetic characteristics are then permanently lost. Thus, large scale devastation of Amazonian forest, as it is now occurring in Brazil, produces wholesale genetic waste (UNEP, 1997).

The second set of concerns related to deforestation in the Brazilian Amazon has to do with the nature of tropical soils. Though soil mineralogy in the moist tropics is complex and varies from area to area, it is generally not suitable to modern methods of cultivation. Clearing land for agriculture is, in general, not only unproductive, except in the short term, but when the forest cover is removed, the thin soil is quickly washed away in rainfall. This exacerbates flooding downstream from deforested hillsides and consequently increases loss of life and property, including more productive agricultural land (Coomes, 1995; Hecht, 1992).

Another effect of deforestation is upon the climate. Local climates are affected in two ways. First, deforestation increases the reflectivity of the land. As a result, local temperatures may become more extreme: hotter by day and colder at night. Second, water vapor, which is normally released to the atmosphere by the trees through transpiration and through direct evaporation of rainfall from leaves, is reduced when trees are destroyed. Humidity also moderates temperatures, and its loss exacerbates temperature fluctuations, reduces soil moisture in nearby areas, and may even affect regional rainfall patterns, though there is considerable uncertainty surrounding this last phenomenon. Destruction of

forests could also affect the global climate by increasing the concentration of carbon dioxide in the atmosphere, though the nature of this relationship is quite uncertain as well. All of these effects can inhibit growth of food crops grown in the area (UNEP, 1997).

The potentially severe negative consequences of tropical deforestation, as outlined, are numerous. Just as uncertain are the values of potential benefits received from the undisturbed natural forest. Where information about costs and gains of alternative uses is particularly poor, due to the long period to which it must apply and the nonmarket character of some of the uses, development decisions need to take into account uncertainty surrounding the potential future benefits from preserving Amazonia ecosystems (Pearce, 1993).

Conversion of natural areas is, in many cases, an irreversible process because extinction, or loss of natural areas is indeed irreversible. Regarding the significance of irreversibility in economic processes and the reasons for concern over disturbing natural areas versus the everyday concerns involving the allocation of other resources of comparable value, Fisher and Krutilla write: "...wild lands and natural populations are the results of geomorphologic and biological processes that represent a time frame measured in eons and, thus, cannot be replaced or restored. There is thus a basic irreversibility that attends the modification of unique scenic or biological environments. These are referred to as 'gifts of nature' since they cannot be reproduced in all their essential features by the efforts of man" (Fisher and Krutilla, 1985:173).

Loss of a species reduces biological diversity and, thus, represents reductions in the options available to society, violating the "central postulate of welfare economics: expansion of choice represents a welfare gain; reduction of options a welfare loss" (Krutilla and Fisher, 1985:43).

Some services of ecosystems are not substitutable at all; and in the case of those that are, the direct and indirect costs of substitution are likely to be high. Even if the survival of a species is not an issue, restoration is not a simple remedy for redressing the impact of an inappropriate decision that disturbed the original ecological environment. In tropical climates, this restoration might be accomplished over a period of several generations

sufficiently to bear at least a superficial resemblance to the original conditions for the less discriminating observer. But it is unlikely that even here the original faunal communities will be reestablished in their original associations and, therefore, the degree of restoration and the importance of "authenticity" must be considered (Rice et al., 1997).

If the *in situ* resources of an environment are declining in value relative to the extractive resources, then, clearly, irreversibility poses no special problem. However, unique natural environments are in many cases likely to appreciate in value relative to goods and services they might yield if developed. In this case, then, the restriction on reversibility matters because value would be increased by going back to an earlier, less developed state (Kahn, 1995; Pearce, 1993; Fisher and Krutilla, 1985).

The gain from being able to learn about future benefits, especially those that would be produced by the project if one does not undertake it right away, is defined as "option value" (Fisher and Krutilla, 1985). Option value, therefore, is the value in addition to consumer surplus, that arises from retaining an option to a good or service for which future demand is uncertain (Tietenberg, 1996; Howe, 1994; Pearce, 1993). Preservation carries with it an option value above and beyond conventional consumer surplus. In this context, there is a "gain from being able to learn about future benefits that would be precluded by development if one does not develop initially -- the gain from retaining the option to preserve or develop in the future" (Fisher and Krutilla, 1985:185).

There is a value to retaining an option to avoid the impact of development. A development project that passes a conventional benefit-cost test might not pass a more sophisticated one that takes account of the uncertain and irreversible impact of the project on the environment. Likelihood of significant consumer surplus and the existence of option value (demand) dictates caution in proceeding with the conversion of unique natural areas to traditional patterns of development. In addition, information is likely to be gained regarding trends in the benefits from development, and from preservation (Tietenberg, 1996; Howe, 1994; Pearce, 1993; Krutilla and Fisher, 1985).

Valuation and allocation of non-priced forest outputs, however, is not straightforward. A unique natural area has, by definition, very limited

substitutes. Future demand for the use of such an area, therefore, has potentially significant, but uncertain, option value associated with it. Whether or not this potentially significant option value involving the preservation of natural areas is taken into account by private developers, however, depends in large part, on how property rights are defined and enforced by governmental institutions (Tietenberg, 1996; Beaumont and Walker, 1996; Howe, 1994; Pearce, 1993; Fisher and Feeny, 1991).

Overall, the central government decisions to connect the Amazon to the rest of Brazil with highways (see Figure 1) caused drastic changes in land use and land rights, making the Amazon, effectively, an "open access" resource. Existing land-tenure institutions were not adapted to treat land as a valuable negotiable commodity on the scale that these sudden changes required (Alston et al., 1995). The state government sold vast tracks of land in a disorderly and frequently corrupt fashion. The licensed land registry offices found themselves swamped both by legitimate requests to transfer properties whose titles were flawed by previous, unregistered sales and inheritances and by demands to register and sell fraudulent titles. Banks solved the dilemma of increasing and profitable demand for agricultural credit in a situation in which the conventional guarantees in titled property were either unavailable or unreliable by pressuring local state agencies and the national agencies to legitimate the land claims of the large-scale enterprises which were borrowing money from them (Alston et al., 1995).

The large ranching and lumbering concerns used various tactics, such as purchasing old or lapsed titles, forging and fraudulently registering deeds, buying state lands, or simply occupying land to assert legal claims to lands that migrating peasants had already settled. In addition to subverting prior land-tenure institutions, they also subverted the state's control of its own armed force. They colluded with local police and military detachments to force the peasants to abandon their lands. They usually offered small sums for clearing, building and planting that the peasants had done and then used violence to remove those who would not leave. Some of these disposed peasants remained as employees for the burning and clearing of land for pastures. Most pushed farther into the jungle and started the process of clearing and eventual expulsion all over again (Alston et al., 1995).

The way a publicly owned "open access" natural asset is used (managed) depends on how the rights to services of the property are assigned and enforced. When a given natural resource such as the Amazon forest is made (legal or not) available to more than one resource user, the result is a free-for-all, with users competing with one another for a greater share of the resource to the detriment of themselves, the resource, and society as a whole. Unrestricted exploitation under "open access" promotes degradation and depletion as individuals rush to obtain as much as they can before other claims are made. The exercise of self-interest runs counter to the collective intent of all resource users and, if pursued generally, is self-defeating (Feder and Feeny, 1991; Vincent, 1990).

In the context of land use patterns in Amazonia, clearing the land for pasture has been the predominant method of claiming ownership of otherwise "open access" lands. This can be explained, in part, by the fact that the cost of policing investment in a standing forest, perennially "attached" to the ground, is high, where as cattle can be branded and driven home at night (Hecht, 1992). In this case, producers (and ultimately consumers) are not paying for the full social costs of deforestation and environmental degradation associated with cattle production. If property rights were priced correctly, the product would be more expensive, less would be purchased and produced, and destruction of the Amazon would be lessened. Thus, institutional arrangements influence the definition of the problem, and so determine the perception of the optimal social policy response to environmental problems (Beaumont and Walker, 1996). However, the simple metaphor of market failure followed by government intervention, is too simplistic. It is inappropriate to assume that government mandated controls will fix environmental problems.

The analysis of Barry Fields (1985) illustrates that the commons (and varying degrees of commons) may be an efficient arrangement once transaction costs are accounted for. He concludes that those who arbitrarily advocate exclusive property rights as a way to handle degradation of the Amazon (commons) are apt to be quietly ignoring the costs of defining and enforcing those rights along with the costs of reaching an agreement. The important point is to recognize that there is a continuum of land-use

forms, not just two discrete types, private or common. Policy should attempt to strike a balance between common-property externalities, transaction costs, and exclusion costs (Fields, 1985).

Framing land use decisions in a common property "open access" context, highlights the important role institutions and institutional design plays in the decision making process. How property rights are defined and enforced, in effect, determines how lands will be managed and how costly administration will be. With these thoughts in mind, we can now turn to actual policy formulation (recommendations), and draw conclusions regarding appropriate avenues of reform.

RESPONSIBLE DEVELOPMENT FOR THE BRAZILIAN AMAZON

Efficient use of the natural resources of the Brazilian Amazon depends on the institutions in place governing development. The possibilities for effective institutions, however, are bounded by the effects of previous uses of the environment. Transformation of vast areas of forest into pasture of short economic usefulness and limited capacity for natural regeneration has already severely limited the potential for subsequent settlement and use of the forest. Sustained economic development will be impossible if short-term economic and political interests continue to disrupt settlement patterns and the ecological systems on which they depend. The current exploitation strategy for the Amazon, in the interests of lessening the effect of international capital flows and maintaining short-term economic growth, promises to restrict the usefulness of the Amazon for whatever purposes it might serve in both the international and national economies of the future. It is imperative that policy makers in Brazil act now to incorporate responsible use of the Amazon in future development strategies.

Howe (1994) defines responsible natural resources policy as the following: "A responsible natural resources policy on the part of the present generation of society consists of a set of rules, inducements, and actions relating to natural resource use that are sufficient to move the economy to an efficient, indefinitely sustainable, nondeclining pattern of aggregate consumption, with no irreversible deterioration of the physical

environment, and without the imposition of significantly greater risks on future generations" (Howe, 1994:331).

Keeping in mind Howe's definition of a responsible natural resources policy, the following important elements should be incorporated into future Amazonian development efforts:

- Avoidance of irreversibilities. The possible losses that might follow from extinction of a natural system must be considered in all policy formulation involving Amazonian development. By following this practice, the narrowing of potential genetic and physical development over time will be avoided. Determination of contiguous areas that permit natural perpetuation of the system are needed, and, along with the implications of different development undertakings outlined earlier, must be taken into account during initial policy formulation and development decision making.
- Clear determination of the role of free markets and prices. The markets can be much more effectively enlisted as a part of Amazonian development policy, particularly with regard to transfer and sale of property. With better defined and enforced property rights, the various management issues surrounding preservation and conservation of forest can be taken into account. Where private interests fall short, the government (or other international bodies) can step in, and through set asides, or outright purchase preserve the undisturbed natural environment until it is decided otherwise.
- Increased support for Amazon research. An attempt needs to be made to better inventory and value Amazonian resources. Given the nature of emerging problems associated with Amazonian development and the "public good" nature of knowledge generated through research, support should come from both the Brazilian government and the many international agencies concerned with development.

By some calculations, Brazil could make a much better living from keeping its forest and exploiting it sensibly than from destroying it. Botanists studying the value of forest products in local markets reckon that fruit, nuts and rubber may be worth more than twice as much as the same land logged or turned into cattle pasture (Smith, 1999). The best way the rest of humankind could help to

save the Amazon would be to help Brazilians realize the region's potential as a standing forest. Commercial companies, particularly from the rich countries, need to increase resources and research support for identification of new medicines, aromatic oils, timber, and other marketable products of the rain forest, and for showing how they might be sustainably exploited. In addition, by helping to finance and strengthen Brazilian research institutes that already exist, and by turning the Amazon into a vast research laboratory, willing governments could help to internationalize the rain forest by the back door, pack it with geographers, botanists, climatologists, hydrologists, and pharmacists who will bring in spending power and bring out new ideas--scientists are likely to be more successful conservationists than innocent Indians or under-equipped forest guards. The problem arises when the poor country (Brazil) is unable (unwilling) to bear costs by themselves when most of the potential benefits go to agriculture, industry and medicine in the rich countries. If the rain forest standing really has a greater value than the rain forest destroyed, the benefits associated with preservation will need to be paid for by those consumers in the countries that benefit the most.

The problem, in essence, is a two-fold challenge: (1) discriminate among areas slated for conversion; and (2) find ways to finance desired protection. Successful forest management programs, however, are only part of the solution to rain forest deforestation. Forest management will not solve the problem alone because it does not touch on the poverty and debt problems that feed forest destruction. A large proportion of current development policies have destructive consequences for irreproducible natural environments of potentially substantial preservation value. It is important that more sensitive and sophisticated methods of analysis be applied more widely in evaluation of alternatives by Brazilian government public land and resource managers. Pertinent new institutional arrangements and efforts are needed to maximize the present value of net social returns from use of the Brazilian Amazon. Past government policies have led to environmental resource extraction undertakings in which the value of resources harvested is less than the cost of harvesting (clearing), and thus represents a net welfare loss to society independent of the environmental costs associated with harvest activities

(Binswanger, 1991; Hecht, 1992). A large number of projects will likely be eliminated when competent valuation of the true factor and/or resource costs of projects is used.

Many of the more developed countries, and the United States in particular, employed a similar Frontier Economy Model development strategy at a very high cost to the environment when at a similar stage of economic development. Fortunately, the temperate climate and ecosystems affected were relatively forgiving--land has been reclaimed, and forest systems in many cases have recovered. Unfortunately the tropical rainforests of Amazonia are inherently fragile, and not nearly as forgiving. Brazilian government policies, particularly over the last thirty years, have subsidized economically wasteful and environmentally unsound patterns of development (Binswinger, 1991). The combination of tax breaks, development incentives, government subsidies, and land speculation -- not the economic promise of agriculture itself -- have made development of the Amazon a lucrative business for many Brazilian corporations and wealthy landowners. But even where firmly entrenched political interests may benefit from the status quo, strong empirical evidence that certain subsidies and other policies both have impoverished the national treasury and the natural environment has finally increased the pressure enough for elimination (Smith, 1999).

Over the past several decades, the Brazilian national government programs for rapid industrialization and integration of the country have increasingly affected the Amazon. Although some progress in the right direction is being made, the government programs designed to protect the natural and human environments of the Amazon are, unfortunately, still subordinated to programs oriented to producing profits for big business. Until the cycle is broken, and shortsighted destructive uses of the Amazon are stopped, wholesale deforestation will continue, and the potential of Amazonia will never be realized.

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