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FOREST MANAGEMENT IN AMAZONIA:
THE NEED FOR NEW CRITERIA IN EVALUATING DEVELOPMENT OPTIONS

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ABSTRACT

Sustained management of Amazonian forest is nonexistent on a commmercial scale and is in its infancy as a research front. Systems are under trial in Brazil, Surinam, French Guiana and Peru to overcome technical barriers to sustained production. The low priority that has been given to developing and implementing sustainable systems is a reflection of the low weight given to future costs and benefits in presently-used economic calculations. An examination of presently-used criteria in Amazonia suggests that they do not lead to development choices that are in the best interests of the region. Problems include: the lack of connection between discount rates applied to future returns and the biological rates limiting forest growth; inappropriate accounting for environmental and social factors; and common property effects--including the distribution of environmental costs. The result is destruction of the forest, along with its potential for sustainable production through forestry management. Alternatives must be evaluated on the basis of contribution to the well-being of the present residents of the Amazon region and their descendants.

"A human being is worth much more than any economic index"

Tancredo Neves, January 15, 1985,
in his address on the occasion of
his election as President of Brazil.

INTRODUCTION

The blind pursuit of inappropriate economic indices is currently causing explosive deforestation in Amazonia and sacrificing the future well-being of the region's residents. Against this background of helter-skelter "disordered" occupation lies what is perhaps one of the greatest opportunities on the planet for planners to have a real impact on the shape of development for centuries to come. This is because Amazonia is, for the moment, still blessed with a relatively small population and vast areas of minimally-disturbed forest. Brazil's 5×10^6 km^2 Legal Amazon region had a 1980 population of about 12 million, 52% of which was rural (Brazil, IBGE, 1984). Approximately 8% of the Legal Amazon had been deforested by 1988; the cleared area is increasing at about 35,000 km^2 annually assuming a linear trend since the last two years for which satellite data are available. Although the forest is not so vast as many believe, and the agricultural potential of its soil when cleared is also limited, today the opportunity for rationally-planned development is still very real. It therefore behooves all those whose work affects the region, including researchers, planners, and decision-makers, to spend some time thinking about how development decisions in the region are made.

Before one can rationally compare options, one must clearly define criteria to be used and the method for balancing conflicting needs and interests in arriving at a decision. As a start towards constructing a framework for evaluating forestry development options in Amazonia, I will examine the assumptions implicit in the criteria used in forest management and suggest an alternative approach to evaluation. As the Chinese say: "a journey of a thousand leagues begins with a single step."

PRESENTLY-USED CRITERIA

Net Present Value

The normal criteria used for comparing investment choices almost invariably involve calculation of the net present value (NPV) of the expected returns. The logic underlying these calculations fails to indicate choices that really attain the objectives of planners, at least if these objectives were more completely explicit. This applies especially to decisions involving management of natural forests.

The net present value expresses the amount of money that a long-term income would be worth if the rights to the income were to be sold as a package today. First, it is worthwhile to contemplate whether such a monetary value really expresses all that the decision-maker wants. Is making the most money today really our objective? The money we make today can be passed on by inheritance to our children and grandchildren who, we implicitly expect, will be able to use it to buy a better life proportional to the amount of money passed on. This assumption may be mistaken. The heritage that our children and grandchildren need to inherit most is not a still greater quantity of money which, even correcting for inflation, will not buy back things that have been destroyed--especially natural ecosystems like forests. The physical resource, capable of continued and sustained production, is much more fundamental to pass along than are bank accounts or bars of gold. Myers (1983) summarizes the value of keeping substantial stands of tropical forests, while Weiss (1984) outlines the ethical justifications and legal mechanisms for passing an environmental heritage such as this to future generations.

The environmental services now performed by natural ecosystems, such as recycling water in the atmosphere to maintain the amount and regularity of rainfall, are not easily replaced. This reflects other drawbacks of strictly monetary criteria as a basis for investment decisions: as usually applied, monetary computations do not account for such costs as pollution, climatic change and the aggravation of social inequalities and tensions.

In addition to the inadequacy of money being used as the index used for expressing the desired goal (future well-being), the way the calculations are made also contributes to the long list of past and present environmental disasters that common sense tells us will worsen the human condition for years to come. These are often put down to incompetence, bad luck, or short-sightedness--but actually many of these can be better explained as perfectly competent application of accepted decision rules that are founded on faulty logic.

Discount Rates

Rapid discounting of future events and benefits, as compared with those expected over the short term, has so far obstructed development and application of sustainable forestry systems. The usual way to calculate the net present value of a potential investment, such as a forestry scheme, devalues future production and cost by a discount rate. For example, if one assumes that inflation is adequately corrected for by a scheme such as Brazil's National Treasury Orders (OTNs: a monetary index adjusted for inflation monthly which is used for many debt and price schedules), then a value today--for example 1000 OTNs-- with a discount rate of 10% per year, can be thought of as equivalent to 100 OTNs received this year, plus a value to be received next year expressed as 100 OTNs / 1.10, plus a value to be received the following year expressed as $100 / (1.10)^2$, and so forth, the exponent of the denominator increasing by one each year. The term "1.10" in the denominator represents the 10% discount rate. The example in Table 1 illustrates the way that discounting leads to destruction of potentially renewable resources like forests. In this hypothetical case, an arbitrary 100-year time-horizon is used in comparing destructive exploitation with sustainable management. Computations are made using discount rates of 3% and 10%, assuming that the cost of a one-time destructive harvest is five times the annual cost of sustainable management, while the sale value of the clearcut forest is ten times that of the annual sustainable harvest. Destructive exploitation is indicated when the 10% discount rate is used, whereas sustainable management is favored under the 3% rate. The example makes evident the great speed with which future costs and benefits are devalued when commonly-used rates (such as 10%) are applied. This situation inevitable leads to decisions that favor even modest short-term gains over what may be tremendous long-term benefits, and that can ignore literally catastrophic long-term costs.

(Table 1)

When the values of various options are compared, their NPVs are judged against a standardized discount rate that reflects the income that can be obtained by investing in other alternative activities. The conclusions made are often highly sensitive to the discount rate used. Alternatives for an individual investor would include lending the money to someone else by putting it in a savings account at a bank. A large company might be comparing profits obtainable from investing in long-term management of Amazonian forest with those expected from cutting down forest to plant <u>Eucalyptus</u> or cattle pasture, or from undertaking investments in completely different locations and sectors of the economy.

Selecting discount rates for financial analyses is an entirely subjective process, despite the superficial impression of objectivity given by the numerical computations in which these rates are used. Discount rates can be selected either above or below a "switchover" value at which a cost-benefit analysis will indicate whatever conclusion the analyst might wish. A.J. Leslie (1987a,b) has eloquently argued that the high discount rates used in financial analyses systematically underrate the profitability of managing natural regeneration in tropical forests, and that economic merits alone are sufficient to make this the rational land use choice in much of the tropics.

Financial indices vs. biological limits

The problem with financial analyses using discount rates based on income potential from alternative investments is that the rates of return to be expected from, say, a new factory in southern Brazil's CubatÔo industrial area are fundamentally different from the biological rates that limit the rate of return one can obtain from Amazonian forest. The rates at which trees grow and reproduce to replenish individuals removed from a population are low, and can only be increased by human intervention up to a point--a point that is still quite limited and still has no logical connection whatsoever with the returns available from alternative investments in other sectors of the economy. When standard discount rates (on the order of 10% per year) are compared with returns from the forestry sector (on the order of 3% per year), the forest is sacrificed for unsustainable uses with higher short-term returns. The madness of this "logical" choice should be obvious.

Ways of shifting the balance toward sustainable management include use of lower discount rates for judging forestry projects (*e.g*. Row *et al*., 1981), adjusting present value calculations to correct for expected increases in the value of forestry products relative to other commodities (Overton and Hunt, 1974), increasing the weight given to future costs (McDonald, 1981), using shadow prices in the calculations to reflect forestry's social benefits (Harou, 1984), and assigning additional weight to irreversible costs such as species extinctions (Goodland *et al*., 1986). Separate discount rates can be assigned to different groups within the population to improve either the ability to forecast the likelihood of systems being adopted (Hoekstra, 1985) or the normative value of project identification for support by government agencies (Price and Nair, 1985). Cost-benefit analysis can make significant contributions to improving decision-making provided the definitions of alternatives, social pricing of resources and products, and procedures for selecting among the alternatives are correct (Price and Nair, 1984). In practice, however, cost-benefit analyses (including their discounting provisions) are frequently manipulated to add legitimacy to projects that have already been chosen for political or other unstated reasons (see Price and Nair, 1984). Adjustments of cost-benefit analysis procedures to incorporate non-financial concerns are rarely made in practice: simple calculation of net present value remains the core of most decision-making. Even most improved formulations of cost-benefit calculations rely on net present value; their greater sophistication does not alter the inappropriateness of present value as a basis for public policy decisions (for an excellent discussion in the context of forestry in the United States see Overton and Hunt, 1974).

The rate at which a population of organisms such as forest trees can be harvested to give the maximum sustainable return, and the maximum rate at which the population can be harvested and still sustain itself, can be calculated from a matrix of birth and death rates by age-group, or from similar matrices for tree populations using size classes rather than ages (Jeffers, 1978: 52-62). Matrices have been developed for only a very few well-studied species of tropical trees, such as *Pentaclethra* macroloba studied by Hartshorn (1975) in Costa Rica. A transition matrix model constructed for tropical forests in Indonesia, managed under a government-mandated system, shows that the system's 35-year harvest cycle is too rapid to sustain the current yield after the second cycle (Mendonza and Setyarso, 1986).

Management systems require consistent, long-term adherence to the harvesting and other regulations derived from technical studies. Corruption, political changes and other impediments can easily thwart the best-laid management plans. In Indonesia, for example, most forest concessionaires find ways to circumvent the management scheme (Eckholm, 1979: 23). In Nigeria, the political changes associated with the end of British rule in 1960 led to clearing of much of the 200,000 ha area that was being managed under the tropical shelterwood system (Lowe, 1977). The CELOS management system in Surinam was abandoned in 1983 following a coup d'état (de Graaf, 1988).

Government agencies give virtually universal endorsement to the goal of sustained forest management, but do not match these ideals through budgetary allocations or other concrete actions. Private entrepreneurs have also failed to invest in developing and implanting such schemes. Logging operators make no effort to determine sustainable use intensities or to restrict their activities to such limits. Although frequently decried as "irrational," this behavior is in fact quite logical under the current system of economic decision rules.

The logic of ignoring the harvest limits indicated by calculations of sustainable yield is most clear in the case of another field of renewable resource management--fisheries and whaling. In the case of the Blue Whale, studies of the populations had shown for decades that the rate at which whales were being harvested would rapidly extinguish the population. Still, companies continued to invest in whaling ships in the full knowledge that they would have to sell them for scrap or convert them to other uses a few years later when the whales had been exterminated. Short-term profitability and rapid write-off of equipment investment made this financially attractive. The investment decisions were not the result of "short-sightedness," nor of a lack of scientific knowledge, but rather of cold and competent reasoning based on an underlying logic that needs to be rethought.

Rapid discounting of future returns leads to decisions to harvest natural populations at unsustainable rates, leading to elimination of populations and extinction of species when the discount rate is more than twice the maximum reproductive potential of the population (see Clark, 1973a,b, and 1976 for mathematical proof). The same relationship can be expressed in terms of a critical point at which it becomes economically "rational" to invest in unsustainable systems rather than sustainable ones, while investing the proceeds in other ventures as fast as they come in. The point is reached when the ratio of the net profit rate for irresponsible management to the net profit rate for responsible management becomes greater than or equal to a "golden number" derived from the available rate of return on alternative investments and the time that the undertaking could run at a profit if managed unsustainably (see Fife, 1971 for mathematical proof).[1]

Common Property

Irresponsible use of potentially-renewable natural resources is further encouraged in many situations by what is known variously as the "common resource dilemma," the "prisoners' dilemma" and the "tragedy of the commons" (Hardin, 1968). In cases such as the exploitation of whales it is "rational" for the independent nations, firms and individuals involved to harvest the population as fast as possible rather than to adopt a lower (potentially sustainable) harvest rate; they knowingly destroy the resource because each perceives that the others will do so anyway. The same dilemma applies to logging in public lands carried out by independent firms and individuals, and to situations where the costs of exploitation are widely distributed, such as climatic effects of deforestation or social tensions resulting from concentration of land tenure. The logic applies even if the total cost to society far outweighs the total benefits from any given form of land management.

Risk

Applying NPV is often further flawed by less-than-full weight being given to risk and uncertainties. The lack of understanding of decision processes is shocking given the importance of the decisions at stake, including those involving sustainable forest management. Little has been done to improve our knowledge of how people arrive at decisions that involve a range of probabilities of different outcomes and varying degrees of confidence in the information base available. The field of decision analysis makes explicit the calculations involved in weighing these effects, but the fundamental input to the calculation--the "risk indifference curve" for those making the decisions--is difficult to quantify and virtually non-existent for the various types of actors that are now playing major roles in transforming tropical forests to other uses, both sustainable and unsustainable.

Traditional farmers, such as Amazonian caboclos, are usually highly risk-averse (Raiffa, 1968; Lipton, 1968 cited by Shanin, 1974: 72; Found, 1971: 108). They often behave in ways that aim to increase their security of obtaining a minimum acceptable harvest, rather than jumping at opportunities to maximize the expected monetary value of their undertaking by opting for land use indicated as "rational" by simple application of linear programming. As market economies expand in areas of predominantly subsistence-oriented decision-making, a rapid increase occurs in the role played by efforts to maximize profits at the expense of accepting greater risks. In Peru, for example, traditional farmers were quick to become commercial loggers (with little regard for sustainability) when transport and marketing opportunities entered the Amazon area (Durham, 1977).

In areas of pioneer settlement, the mix of different risk-taking strategies is extremely varied. While a series of behavioral buffers protects such colonists from some of the variability in agricultural success from year to year, many decisions observed can only be described as gambling--people's acceptance of high risks in the hopes of obtaining a payoff that would otherwise be beyond their grasp (Fearnside, 1980).

Large enterprises can afford to take greater risks on individual undertakings than can small farmers. At the same time, large firms in general spend a greater proportion of their resources in trying to secure their long-term survival than do small ones (Galbraith, 1972; see Helliwell, 1977). Sustainable forestry management should be most attractive to large firms since the principal attraction of this land use is its offer of long range stability rather than quick profits. The large areas required to guarantee an adequate harvest rotation also make big operations most appropriate. It is important to remember that large management units do not necessarily exclude individuals with modest resources, as such people could join together in cooperatives for forest-management purposes given the proper institutional support.

In terms of research, one of the greatest shortcomings is a better evaluation of the risks implied by different management schemes. Many of the data essential to rational risk evaluation are unavailable: such basic data as rainfall measurements spanning even a few years are often lacking for the locations in question. In a region where rainfall varies greatly over short distances and from one year to the next, this can be critical (Fearnside, 1984a). The classic example of this is Britain's massive groundnut plantation fiasco in Africa in the 1950s--a scheme based on a mean rainfall adequate for the proposed crop but ignoring the high variability from year to year. Variability in rainfall, as well as in other factors affecting production, is an important factor in limiting human carrying capacity (Fearnside, 1986c). In addition to the need for better data on variability, much more work needs to be done on the means to rationally incorporate such information into planning decisions, especially when the risks involved go beyond the chance of losing the money invested.

Development plans often ignore the unsuitability of physical factors at the target location even when the data exist (Fearnside, 1986d). This pattern is frequently explained by such factors as: political influence of the location chosen; financial rewards to the firms that build the roads and other infrastructure, or supply goods and services to the construction activities; and speculative profits to landholders in the areas served by new roads and programs. Departures from technically-sound plans motivated by factors such as these can have high financial, environmental and human costs.

FOREST MANAGEMENT IN AMAZONIA

Brazil

At present, no sustained management system is operating on a commercial scale in lowland Amazonia. Commercial forestry practices are reviewed by Palmer (1977) and Rankin (1985). Development of experimental systems is still incipient when compared with the testing programs in Asia and Africa but research initiatives are slowly increasing in frequency. Surveys of seedlings and saplings from natural regeneration in Amazonian forest, and subsequent experimental trials of forest management systems, first began in 1955 at Curuá-Una (near Santarém, Pará) under a bilateral agreement between the Food and Agriculture Organization of the United Nations (FAO) and the Brazilian government (Pitt, 1961). In 1963, a trial was installed for testing the Tropical Shelterwood System (TSS) originally developed by the British in Nigeria (cf. Lowe, 1977). The system involves cutting climbers and uneconomic saplings and poisoning of some larger trees of uneconomic species several years before harvesting, followed by a selective harvest and a removal of climbers and "shelterwood" several years after the harvest. The maintenance of "shelterwood," or trees shading the understory, keeps microclimatic conditions favorable for the tropical hardwoods throughout the cycle. Early results are summarized by Dubois (1971); natural regeneration remains encouraging as the first growth-cycle advances (Rankin, 1979, 1985). The research program suffered a decade of neglect after the bilateral agreement terminated in the early 1960s, but was resumed in 1973 under an agreement between FAO and the Superintendency for Development of Amazonia (SUDAM). Evaluation of tests with about 15 years of growth, comparing enrichment plantings of seedlings with natural regeneration of the same age, impressed SUDAM with the better growth and form of natural regeneration (Pandolfo, 1985). The great expense of transporting, planting and maintaining significant numbers of seedlings is also a major factor in favor of systems based on natural regeneration (Rankin, 1979). The term "natural regeneration" as used in forestry management schemes of this type refers to growth of volunteer seedlings and saplings under more-or-less intact forest canopy, not to the growth of secondary vegetation in clearcut areas that is sometimes euphemistically referred to by the same term.

At the Tapajós National Forest (FLONA), tests were implanted in 1975 by the Brazilian Institute for Forestry Development (IBDF) with exploitation at different intensities (de Carvalho, 1985; GalvÔo, 1985). Silvicultural treatments to be applied to the plots during the expected 20-25-year period between harvests have apparently not yet been chosen, but may include cutting vines, eliminating malformed or otherwise defective trees of commercial species, and eliminating some non-commercial trees (de Carvalho, 1985). With three years of post-harvest growth measurements, the rate of increase in basal area was greater under lighter (lower limit for harvest = 55cm DBH) than under heavier (lower limit for harvest = 45cm DBH) exploitation when only commercial species were considered, but showed the opposite tendency when the comparison was made for all species (de Carvalho, 1985: 12). Interpretation of the results is hampered by undocumented exploitation of the area before the studies began (see Rankin, 1985). Because of the slow rate at which forests regain natural equilibria, even a light disturbance can prevent subsequent studies from producing valid results on the effects of management treatments. Management effects on the growth of large trees (as opposed to seedlings and saplings) are particularly difficult to establish under these circumstances; previous disturbance has prevented establishing such links in studies in Nigeria (Lowe, 1981). The regeneration of seedlings following selective felling is considered satisfactory in the FLONA experiments (de Carvalho, 1980, 1984), although data from a full harvesting cycle will be necessary to confirm the sustainability of the system (Rankin, 1985).

At the Jari project, the Brazilian Enterprise for Agriculture and Ranching Research (EMBRAPA) and IBDF installed a series of 0.25ha plots in 1983 (GalvÔo, 1985). The plot design and treatments are the same as those at FLONA, although there are fewer plots (48 plots at Jari vs. 144 at FLONA). One of the two experimental areas at Jari (Felipe, Amapá) is undisturbed.

The National Institute for Research in the Amazon (INPA) has begun a study in its "model basin" (90 km north of Manaus); growth and recruitment, as well as hydrological effects, will be monitored under exploitation at different intensities (Lowe, 1981). Surveys of seedling stocks (Higuchi et al., 1985) and of short-term tree growth (Higuchi, 1987) have been completed in the undisturbed state, but management treatments have not yet begun.

Florestas Rio Doce--the forestry sector of the Companhia Vale do Rio Doce (CVRD) mining company undertaking the Carajás iron project--initiated a forestry management experiment for charcoal production in 1983 at Buriticupu, MaranhÔo. The scheme involves removing the smaller trees (better for making charcoal), together with the understory, in plots exploited at varying intensities (de Jesus et al., 1986, nd. (1984); Thibau, 1985, 1986). The experiments include treatments with clearcutting and with heavy exploitation that leaves only a few scattered trees in an otherwise clearcut field. In 1985, C.E. Thibau, president of Florestas Rio Doce and designer of the study, pointed with enthusiasm to the rapid growth of secondary vegetation in the clearcut and near-clearcut treatments. Despite subsequent disclaimers that clearcutting was included in the experiment merely as a second control (Renato Moraes de Jesus, public statement, 1988), written presentations of the experiments use the term "control" exclusively with reference to undisturbed forest, and present clearcutting as treatment number three of five treatments (de Jesus et al., 1986: 246). The propriety of considering as "forestry management" a practice that removes all of the forest is questionable.

The Buriticupu forestry management experiments have great potential impact on deforestation in the region because of legal and semantic questions regarding "forestry management," plus the tremendous demand for charcoal implicit in the pig-iron production schemes being established for the processing of ore from Carajás (Fearnside, 1986a,b, 1987, 1988; Fearnside and Rankin, 1982a). Brazil's 1965 Forestry Code (Decree Law 4771, Article 44) requiring that 50% of any property remain under natural forest cover has been reinterpreted by IBDF (Normative Instruction 302 of 3 July 1984) to allow clearing for annual crops or pasture in 20% of each property and "forestry management" in the remaining 80%. If "forestry management" is interpreted to include clearcutting followed by leaving the area to secondary vegetation, even if (at least theoretically) with a view to subsequent harvests, then the legal obstacles will be removed to rapid deforestation for charcoal production in private lands and in concessions granted to firms exploiting Brazil's national forests. A Eucalyptus plantation almost ten times the area of Jari's silviculture operation would be required to supply the charcoal for the 20 pig-iron plants and four other industries planned for the Carajás region, if yields equal to those at Jari are assumed (Fearnside, 1988). The tremendous expense and numerous biological problems associated with plantations of this scale make it likely that native forest will be cut before such investments are undertaken (see Fearnside and Rankin, 1980, 1982a,b, 1985). Adopting "forestry management" as a euphemism for clearcutting would speed this process.

In 1984 Florestas Rio Doce replicated the experimental design of Buriticupu at Porto Trombetas, Pará (de Jesus, nd (1984), de Jesus et al. nd (ca. 1986)). The scheme envisages producing firewood for drying bauxite ore in the MineraçÔo do Norte (CVRD/ALCAN) mining concession. Another modification of the experiments has been installed in part of CVRD's 17,000 ha tract with a view to charcoal and lumber production (de Jesus and Menandro, nd (ca. 1986)). The much lower cost of obtaining wood from cutting native forest than from silvicultural plantations provides strong motivation for tapping this biomass source even though the long-term sustainability of production is yet to be demonstrated (Fearnside, 1988).

Surinam

In Surinam, the Malayan Uniform System was tested in the

1950s. The system, which calls for poisoning virtually all large trees remaining after a commercial harvest so that the growth of seedlings and saplings will be stimulated, resulted in an explosion of vines and undesirable secondary forest species when applied in Surinam (Jonkers and Schmidt, 1984). Unlike the Southeast Asian forests, which are dominated by commercially valuable dipterocarps, the forests of South America are mostly composed of species with low value on today's markets. Removing the many non-commercial trees radically increases sunlight reaching the forest floor, benefitting weedy species.

Since 1967, workers in Surinam have developed another management scheme--the CELOS Silvicultural System (Boxman et al., 1985; Jonkers and Schmidt, 1984). Following selective logging, about half of the remaining forest biomass is killed by poisoning non-commercial trees above a certain diameter limit (35 cm in Surinam) in order to promote growth of commercial trees that are approaching harvestable size. A subsequent modification of the system restricts poisoning to trees within a 10m radius of commercial trees whose growth is to be favored (Boxman et al., 1985). The system's developers hope for a 40^{m}3/ha timber harvest every 20 years, although they caution that long-term monitoring will be necessary to confirm that productivity will not be reduced by the drain of nutrients they observed in streams leaving the treated plots (Jonkers and Schmidt, 1984: 296).

French Guiana

In 1982, testing began in French Guiana of a management system consisting of the selective harvest at different intensities for timber, firewood or both, followed by poisoning of non-commercial trees (Bariteau, 1986; Maitre et al., 1984; Sarrailh and Schmitt, 1984). The system is based on earlier work in the Ivory Coast, and is similar to the CELOS system in Surinam. Diameter increases measured in the undisturbed forest in French Guiana (6.20 mm/year) and in the first year after treatment (9.50 mm/year) make the researchers optimistic that the work will lead to an economically viable system of sustained production (Schmitt, nd (1984)). The researchers in French Guiana emphasize the similarity of treatment effects to those found in Surinam, where average diameters in commercial species in selectively-logged forest grew at 4 mm/year if untreated and 9-10 mm/year under the CELOS system (Jonkers and Schmidt, 1984).

Peru

In Peru, application of a management plan called the "Protective Strip System" began in 1982 in the Piches-Palcazú Project, located in a 20 X 70 km valley in the lower foothills of the Andes at elevations ranging from 270-500 m (Hartshorn et al., 1985). The system calls for clearcutting strips of forest 20-35 m in width following the contour of the valley. Strips cut in successive years would be at least 200 m apart, and the planned rotation would return to each strip at intervals of 30 years. A similar system has been suggested by Jordan (1982, 1985: 154) as a means of speeding succession in the harvested strips. While it is far too early to assess the system's sustainability, the first cycle of harvesting has been profitable and the research team is enthusiastic about the system's potential for wider application (Hartshorn et al., 1985, 1986).

Development Policies

The increasing frequency of research inititatives aimed at developing sustainable systems for managing Amazonian forest is heartening. However, the funding devoted to research in this area is minimal in comparison to the importance of the resource at stake. Rapid deforestation in Amazonia, especially for unsustainable cattle pastures, means that decision-makers are likely to be forced to act on forest management schemes in the absence of long-term testing. Two such large-scale programs have been proposed in Brazil: the "income forests" scheme put forward by SUDAM (Pandolfo, 1978) and the forest utilization or "risk contract" scheme of FAO and IBDF (Schmithu"sen, 1978; see Fearnside, 1986c: 33-34). The management programs to be applied are vague in both cases: as Mauro Silva Reis, then head of Brazil's now dissolved Project for Forestry Development and Research (PRODEPEF), observed: "in truth, a self-sustained system of production for the dense tropical forest for industrial ends, based on the model considered here, has not yet been developed" (Reis, 1978: 14). Neither of these programs has gone forward: in addition to technical uncertainties there is little commercial interest, the schemes would require heavy government expenditures, and, in the case of the "risk contracts" plan, the proposed involvement of foreign timber firms provoked widespread opposition.

In 1986, the Brazilian Institute for Forestry Development (IBDF) began requiring the submission of an acceptable "management plan" as a condition for issuing logging permits. In addition to the confusion over what constitutes a "management plan," there is a lack of research results because of the low priority this field has received. The same economic forces that explain the absence of commercial sustained management systems in Amazonia today can be expected to result in entrepreneurs attempting to find ways around the new regulations. Brazil's informal system of "jeitos" makes enforcement of such regulations difficult (Rosenn, 1971). Unless the basis of economic calculations is changed, the motivation to circumvent the new "management plan" requirements will be strong.

The degree to which management interventions should perturb the natural ecosystem is a matter of much disagreement and presents ample opportunity for Orwellian doublespeak. "Sustainable management" and "natural regeneration" conjure up images of an environmentally-benign tapping of the forest's productive potential without destroying the existing ecosystem. However, it is quite possible to "destroy the forest in order to save it" by going too far along the continuum of increasing management intensity. For example, poisoning a large percentage of the trees in the Amazonian forest may maximize commercial timber yields, but would sever many poorly-understood ecological pathways and sacrifice as-yet unexploited and/or unknown products such as genetic material and pharmaceutical compounds. The increasing value and the irreplaceability of many of the potential benefits of forest use could mean that intervention should be kept below the intensity indicated by timber management considerations alone. Determining the response of timber production to different intensities of management and the ecological changes provoked at each intensity should be urgent priorities. Rational decisions will also require assessing the many non-timber forest products, knowledge of which is rapidly being lost with the disappearance and acculturation of indigenous tribes.

ALTERNATIVES TO PRESENT CRITERIA

Elsewhere (Fearnside, 1983), a series of guidelines has been proposed for evaluating 14 classes of land-use options in Amazonia, including sustainable forest management. Nine criteria were considered: agronomic sustainability, social sustainability, unsubsidized economic competitiveness, self-sufficiency, achievement of social goals, consistency with maintenance of adjacent areas in other uses, retention of development options, effects on other resources, and macro-ecological effects. Conflicts among these criteria often highlight fundamental inconsistencies in the goals of development planners (Fearnside, 1984b). While some conflicts of interest are unable to be resolved, many divergent needs and demands can be attended to through a planning strategy aimed at producing a patchwork of land uses where different environmental and social criteria are applied (Odum, 1969; see Eden, 1978; Fearnside, 1979; Margalef, 1968).

The role of net present value as the criterion used in economic decision-making at all levels is the root of the current state of affairs where neither government research and financial agencies nor private enterprises are willing to invest more than token amounts in the development and application of sustained-yield forestry systems. While a satisfactory alternative to this criterion has not yet been developed, some suggestions might be made as to how to begin. Projects should be evaluated on the basis of contribution to the well-being of the present residents of the Amazon region and their descendants. Benefits must accrue to all levels of society and future as well as to the present. The limitation of planning to Amazonia's present residents and their descendants recognizes the region's inability to offer solutions to the socio-economic problems of other countries or regions of Brazil. These are problems that must be recognized and solved within those other regions--not postponed by the combination of passing immigrants to Amazonia and removing marketable products from the region for the benefit of non-residents. Recognizing these limits would allow the realization of the greatest hope in the region--the possibility of designing sustainable systems that attend to local needs for centuries to come. Constraints on development options should include the limitation of macro-ecological effects such as climatic changes, the attainment of a defined distribution of income, and maintenance of the human population within the bounds of carrying capacity. Once a decision-making framework has been that recognizes the value of human beings in this way has been devised and adopted, then the choices of forest species and management techniques will come automatically as the nation's efforts are focussed on solving the remaining technical barriers to sustainable forest management. Until underlying economic decision processes are changed, however, no amount of research on management techniques can be expected to alter what is now the most salient fact about sustained management of forests in Amazonia: that no one is doing it.

NOTES

(1) Irresponsible management becomes "rational" when:

$$\frac{{}^{N}\text{irresp.}}{{}^{N}\text{resp.}} \;\_\; \frac{e^{{}_{r}\text{alt.}\ t}}{e^{{}_{r}\text{alt.}\ t} - 1}$$

Where: ^{N}irresp. = the rate of return from irresponsible (unsustainable) management (dollars per year)

^{N}resp. = the rate of return from responsible (sustainable) management (dollars per year)

${}_{r}$alt. = the rate if interest (dividend) on available alternative investments (dollars per dollar-year)

t = the time the resource can be exploited at a profit under irresponsible management (years)

e = the base of natural logarithms (2.l7l28...)

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