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Brazil: An Analysis of Environmental Problems in the Amazon Annexes

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Annex I.
Population Growth and Migration in the Amazon

1. Introduction Population growth, migration, and government settlement policy have strongly influenced the rate of development and deforestation in the Amazon in the past (Mahar, 1989). The purpose of this chapter is to gain a perspective on the likely future role of population pressure. This appendix discusses the levels and trends of inter-regional migration, including the origins and destination of migrants, their socio-economic composition, and their urban-rural distribution. In addition it discusses the trend towards urbanization, and reviews the factors leading to stability or instability of settlements.

Levels and Trends

2. The volume of inter-regional migration to the Amazon in recent decades has not been as large as is often presumed, especially when net migration is considered. Carvalho and Moreira (1976) estimated net migration to the North region at only 61,427 between 1960 and 1970. Wood and Wilson (1984:148) estimated net migration to the region at 766,435 between 1970 and 1980. This compares to some 16 million net rural-urban migrants in Brazil in the same period.

3. Migration to the Amazon is often assumed to be growing constantly or even exponentially. There is a common sense idea that economic crisis in the 1980s, which may extend into the 1990s, intensified migration of the poor and unemployed to the Amazon. However, the impressions of growth of migration and of a positive relation between frontier migration and economic crisis (recession, austerity, unemployment, wage squeeze, etc.) may both be wrong, for reasons which are discussed below (see Sawyer 1989c).

4. Migration may decline in relative or absolute terms for a series of economic and social reasons:

- a. Stagnation on the frontier. Settlement has not been generally successful in improving the quality of life of migrants, thus reversing previous expectations (e.g. Moran 1975, Butler 1985, Torres 1987).
- b. Reconcentration of modern agriculture. Modern productive activities (including agriculture) tend to concentrate in already developed areas where economic and social infrastructure is present (Sawyer 1984).
- c. Social change. New generations have lifestyles and aspirations that are

not compatible with chopping down trees in a malaria-infested jungle (Sawyer 1983, Torres 1990).

5. Empirically, there is evidence of declining migration in the 1980s. The data on migrants counted at the Vilhena checkpoint presented in Table I-1 show a sharp drop after 1986¹.

6. The complexity of the road and urban network on the eastern flank make it more difficult to track migrants. The only way to gauge migration trends in these areas would be to arrive at current population estimates (probably using SUCAM data and symptomatic indicators such as voting registration, school enrollment, church records, etc.) and subtract estimated natural population increase, yielding estimated net migration².

7. There is also evidence of a low level of occupation of colonization projects opened in the 1980s. In 1987, CEDEPLAR found families living on only 50% of the lots in the tracts of the Machadinho settlement project distributed in 1984, with unusually complete infrastructure (Ferreira 1984, Sawyer and Sawyer 1987). The nearby Cujubim project, also undertaken with World Bank support as part of the POLONOROESTE initiative, had even fewer inhabitants (CBC program by David Suzuki). There are reports that 70% of the lots in the Carajás colonization project in Pará were abandoned (cited in Roberts 1989).

Table I-1

Migration to Rondônia, 1979-1989.

Year	Number
1977 (a)	8,280 (d)
1978 (a)	12,658
1979 (a)	36,701
1980 (a)	49,205
1981 (b)	60,218
1982 (b)	58,052
1983 (b)	62,723
1984 (b)	153,327
1985 (b)	151,621 (e)
1986 (b)	165,899
1987 (c)	103,654
1988 (a)	51,950 (f)

Sources: 1977-1983 - MURE-MIGR-RD (1984:Tabela 01), 1984-1985 - Boletim de Migração, v.5, n.13, p.9., 1986-1987 - Boletim de Migração, v.7, n.20, p.7.
 Notes: (a) Data for CETREMI in Vilhena only. (b) Data for CETREMI 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. (f) Possible problems of coverage in second semester, due to financial difficulties of program. However, second semester total (25,528) was nearly as large as first semester (26,422).

¹ Data from SIMI (Information System on Internal Migration) stations in the eastern Amazon are not very meaningful because they are not 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 (BR-316), the "Mato Grosso road" (BR-158) and the Cuiabá-Santarém (BR-163). Furthermore, cities in neighboring states such as Imperatriz in Maranhão (Bitoun 1980) and Araguaína in Goiás (Hebetete and Acevedo 1980) also serve as nodal points for migrants.

² - Sawyer (1969) used symptomatic indicators to estimate current population for areas along the Belém-Brasília highway in the late 1960s, but the method has hardly been used in Brazil, in spite of its importance for small areas undergoing rapid change (Perpétuo 1990).

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8. Frontier migration may not be sensitive to macroeconomic conditions for various reasons: the vigor of the informal sector in urban areas, the slowing of modernization of agriculture (i.e., less expulsion) given credit restrictions, the lack of resources to migrate long distances, and the lack of public and private investments which would attract migrants to frontier areas (Sawyer 1989c). If and when the "crisis" is overcome, the structural economic and social transformations under way may make it unlikely that new contingents of migrants will set out on Amazon adventures.

9. There are also demographic reasons for decreased frontier migration in the future. Potential migrants for rural settlement are necessarily socialized in rural areas, and preferably do not have much urban experience. They are the younger generations, generally between the ages of 20 and 40. Table I-2 shows Brazil's non-Amazon rural male population age 20-39, which can be considered potential migrants to the Amazon, from 1940 to 1980.

Table I-2

Rural male population age 20-39, Brazil, 1950 to 1980.

Year	Non-Amazon rural males age 20-39 a/	Total population of Brazil	%
1940	3,925,307	41,165,289	9.5
1950	4,653,080	51,941,767	9.0
1960	5,168,632	70,070,457	7.4
1970	5,299,237	93,139,037	5.7
1980	5,308,915	119,002,708	4.5

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

10. The stock of potential migrants ceased growing in the 1970s, and in 1980 its share of Brazil's total population was less than half of what it was in 1940. This can be attributed to rapid urbanization, reaching 67% in 1980, and to fertility decline, which began in the mid 1960s and affected the rural as well as the urban population (Merrick and Berquó 1983, Fernandez and Carvalho 1986). By 1990, the fertility decline and urbanization will undoubtedly provoke an absolute drop in the stock of potential migrants.

11. When the probable trends in migration, fertility and mortality for the regions of Brazil until 2010 are taken into account, the population size and distribution depicted in Table I-3 can be foreseen. In 20 years, the North Region increases its share from 6.2% to 7.7%.

12. Origins and Destinations The main sending areas of migrants to the Amazon have been the Northeast, Minas Gerais, Paraná and Mato Grosso (Carvalho and Moreira 1976, Keller 1977, Hakkert 1990). It should be noted that increasingly the sending areas are themselves former frontier areas that have begun pushing out migrants, many of which were not born there. For example, a large proportion of the migrants who arrived in Rondônia from Paraná were born in Minas Gerais, and migrants from Mato Grosso to Rondônia were often born in

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Table I-3

Paraná (INCRA records in Ariquemes, field surveys in Machadinho). This out-migration from Paraná and Mato Grosso is a reflection of what Martine (1987) has called shortening of the cycle of frontier expansion and retraction. The contemporary frontier quickly becomes a source of migrants to other areas further inland or to cities.

Population projections, by state, North Region, 1990-2010.

State	1990	2000	2010
Rondônia	1,232,184	1,774,025	2,332,680
Acre	429,633	587,884	765,735
Amazonas	2,008,062	2,570,441	3,151,438
Roraima	208,582	330,386	484,613
Pará	4,989,163	6,435,588	7,839,248
Amapá	252,231	336,347	442,706
Total	9,094,805	12,036,651	15,016,420
Brazil	146,730,000	171,076,000	195,225,000
North/Brazil (%)	6.2	7.0	7.7

Source: Hakkert 1990:23.

13. The main receiving areas in the North Region have been southern Pará and Rondônia (Carvalho and Moreira 1976, Keller 1977, Hakkert 1990). There is now migration to Acre and Roraima, on a lower scale (Sawyer coord. 1990). Other areas in the Amazon, particularly Amazonas, Amapá and southwestern and northern Pará, have attracted few if any migrants, especially to rural areas, and have even shown negative net migration (Sawyer 1984).

14. Socio-Economic Composition In addition to the volume of migration, it is important to examine its socio-economic composition. Occupational background, levels of education, previous exposure to modern technology, experience with management and consumption patterns have much to do with the outcome of migration (e.g. Wood and Schmink 1979, Wesche 1982, Moran 1984, Torres 1987).

15. In the past, migratory flows consisted primarily of poor Northeasterners moving into the eastern Amazon (Velho 1972, 1976, CEDEPLAR 1977, CEDEPLAR 1984, Schmink and Wood 1989) and somewhat better-off southerners moving into the western Amazon (Calvente 1980, Jatene 1983, Kinzo 1982, 1986, Millikan 1988). The southerners are supposed to have been more successful, at least in relative terms (Almeida and David 1981a, 1981b). It is possible that from now on there will be important changes in composition and in the insertion of migrants.

16. As rural migrants from the South become disillusioned with the prospect of having land of their own on the frontier, either because they cannot get it (Schmink and Wood 1989) or because they cannot make a living off whatever land they get (Torres 1987), they may decrease rapidly in numbers. The southerners are supposedly the migrants of best "quality" in terms of experience with technology, literacy, etc. (field interviews with INCRA staff on the Transamazon highway in Altamira in 1972). Thus, from now on there may be relatively more migration from the Northeast, not because Northeasterners do better in the Amazon, but because they have fewer alternatives in their areas of origin.

17. A shift in the composition of migrants to the Amazon toward the poorer

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groups may aggravate what already seems to be the "double jeopardy" of the regional brain drain. In addition to losing its talented and educated individuals to more developed regions, the Amazon seems also to receive the least qualified migrants from the rest of Brazil, the reverse of the brain drain. It is not clear, however, that southerners make better settlers in rural parts of the Amazon (field observations, Moran 1975, 1981).

18. Social Dimensions Migration and urbanization in the Amazon are due not only to economic trends, but also have a very important social dimension. Past generations were willing to make their own way into the backwoods, but new generations seem to be less enthusiastic about pioneer life in the jungle (Sawyer 1983, Torres 1990). They have different lifestyles, especially those that have lived in urban areas and come from more developed regions. Their consumption patterns are different from those of traditional peasants. They want medical care when needed. They also want education for their children, which is in reality not just a social desire but also an adaptation to the new economic structure, in which knowledge is becoming more important than land or labor for making a living.

19. Analysis of the social dimensions of migration and settlement must take into account the differences between genders and generations. In frontier areas, at least non-peasant frontiers, the sex ratio starts very high, but decreases over time (CEDEPLAR 1979:14, Chase 1984). When men circulate more in order to find wage work, women are left with certain economic responsibilities (Chase 1985). While most Amazon activities have typically been masculine (rubber tapping, clearing, mining, construction, ranching, wood extraction, etc.), there are some activities that involve women (babaçu, processing Brazil nuts, laminated wood, services).

20. Rural/Urban Distribution In addition to inter-regional migration, one must also look at rural-urban migration within the region, as well as some rural-rural and urban-urban migration. The question is why migrants do not stay put once they get to the Amazon, i.e. why don't settlers settle down?

21. In 1980, 44% of the interstate migrants to the North Region came from urban areas. There is some evidence for claims that migration to Rondônia is now predominantly urban-urban instead of rural-rural³. Analyzing a new type of question about ever having lived or worked in urban areas (lifetime urban experience), Torres (1988) found that 66.4% of settlers interviewed in the rural part of the Machadinho project in 1987 had resided in urban areas for more than one year and that 10% had lived in the city of São Paulo. Survey data from São Félix do Xingu, Tucumã and Ourilândia, using life histories, also show high levels of previous urban residence.

22. The urban stages of migration do not necessarily mean that the nature of the migration has changed entirely. The urban origin and the urban destination, even when urban occupations are involved, may be circumstantial. Towns may have been the only place to go when migrants had to leave the countryside in their

³ - See the *Boletim de Migração* from Rondônia.

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places of origin and the only place to go in Rondônia while they seek land. In other words, urban-urban migration may to some extent be "disguised" rural-rural migration.

23. Another complication is that some settler families are "rurban", simultaneously rural and urban, combining residence and work in both areas and circulating between them. They are "amphibious" (Sawyer coord. 1990, Torres 1990). For example, it can be seen in Ariquemes, Rio Branco or Ourilândia that part of the temporary rural work force lives in town and commutes on a daily or seasonal basis to do clearing or harvesting as "volantes" or "bóias-frias". Some settler families have a house in town, where the women and children spend most of their time (for school, health, comfort, company), while the men spend most of the time on their lots. Some rural families have family members that work in town. Thus, the urban/rural distinction has become very blurred, at least in terms of families or individuals.

Urbanization

24. Introduction Table I-4 shows urbanization rates (urban population/total population x 100) by region for Brazil from 1940 to 1980. The Southeast, which includes the large metropolitan areas of Rio de Janeiro, São Paulo and Belo Horizonte, and is

Brazil's industrial core, has always been most urban. Although in the past the populations of all regions except the Southeast have been predominantly rural, in the 1970s they all became primarily urban. Unlike large developing countries in Asia and Africa, about two-thirds rural, Brazil, in a similar fashion to many Latin American countries, is approximately two-thirds urban. Internal differences are significant but not dramatic. The North region has always been more urban than the Northeast.

Table I-4

Urbanization Rates, by Region, Brazil, 1940-1980					
Region	1940	1950	1960	1970	1980
North	27.8	31.5	37.8	45.2	51.7
Center-West	21.5	24.4	35.0	48.0	67.8
Northeast	23.4	26.4	34.2	41.8	50.4
Southeast	39.4	47.6	57.4	72.7	82.8
South	27.7	29.5	37.6	44.3	62.4
Brazil	31.2	36.2	45.1	55.9	67.6

Source: Preliminary Synopsis of the 1980 Demographic Census

25. There is much more to urban growth in frontier regions than expansion of the national and state capital cities. Table I-5 shows that the capital cities in the North Region were responsible for 58.5% of the urban population, the remaining 41.5% residing in cities and towns in the interior.

26. Urban-ization rates in frontier areas are probably underestimated due to the lag between the appearance of urban nuclei and their official

Table I-5

reclassification as district or municipal seats. This administrative criterion is used by the Brazilian census bureau to define "urban".

Total, Urban, Capital, and Other Urban Population, by State, North Region, 1980						
State	Total	Total urban	Capital urban (a)	Other urban	% urban	% capital
Rondônia	491,089	228,539	103,850	124,689	46	21
Acre	301,303	132,189	89,799	42,370	44	30
Amazonas	1,430,089	856,617	620,510	236,107	60	43
Roraima	79,159	48,734	43,788	4,946	62	56
Pará	3,403,391	1,667,356	828,776	840,580	49	24
Amapá	175,257	103,735	90,795	12,940	59	52
North	5,880,268	3,037,150	1,775,516	1,261,634	52	30

Source: Demographic Census, 1980

Notes: (a) Sinopse Preliminar, Censo Demográfico, 1980.

27. Some authors exclude from the "urban" category those areas which do

not reach a certain minimum size, such as 2,000 or 20,000 inhabitants. Using the minimum size of 20,000, the urbanization rate in 1980 falls to 39.2% for the North region and 50.6% for Brazil (Faria 1983:125). Thus, 12.5% of the population of the North Region lived in urban nuclei of less than 20,000 inhabitants.

28. Size criteria have different meanings in different settings. In frontier conditions, where distances are large, some nuclei that are small in demographic terms exercise important urban functions. By the criterion of 20,000 inhabitants, the cities of Guajar'a-Mirim, Cruzeiro do Sul, Tefé, Manacapuru, and Conceição do Araguaia, among others, would not be considered "urban" in 1980, in spite of being commercial and financial centers with areas of influence reaching over hundreds or thousands of square kilometers. Even nuclei with less than 2,000 inhabitants, such as Plácido de Castro, Barcelos, Ipixuna, and São Félix do Xingu, can be tiny metropolises within their respective enormous hinterlands.

29. Frontier urbanization is obviously due primarily to migration. Census data show that of the 3,623,756 inter- or intra-state migratory moves ending in the North or Center-West regions between 1970 and 1980, 64% involved migration to urban areas (Sawyer and Pinheiro 1984:14-15). This urbanization occurs principally in the region which Martine and Carmargo (1983) called the "consolidated frontier" (Mato Grosso do Sul, Goiás, and Brasília), but it is also predominant in most of the states they call the "expanding frontier" (Amazonas, Acre, Amapá, and Roraima).

30. In spite of net immigration at the aggregate level for the North Region as a whole, with high growth rates in some micro-regions, in most subareas of the region there is negative net migration. This curious fact--emigration from "frontier" areas--is discussed below.

31. Emigration from parts of the Amazon results from three migrant flows, which can be identified in the census data concerning prior state of residence

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of migrants in the last ten years:

- a. Migration from the old to newer frontiers. The advance of the frontier can behave like a wave, leaving behind it a vacuum or "hollow frontier" (James 1949).
- b. Attraction of population from the entire frontier towards more central regions, following the national tendency of population concentration in the Southeast region, especially in metropolitan areas (see Martine 1987).
- c. Migration to the larger cities within the frontier regions, especially Porto Velho, Rio Branco, Manaus and Belém.

32. Mapping rural and urban population growth rates separately facilitates understanding the spatial distribution of these flows.

33. For the rural population, the contrasts are dramatic. For the older frontiers, the rates are clearly below natural growth, which was 2.5% for Brazil as a whole during the decade. In many micro-regions, especially in parts of Acre, Amazonas, and Amapá, the rates are even negative, indicating absolute losses of population. In the new frontier from Rondônia to southern Pará, on the other hand, the rates are unquestionably above natural growth. This belt is the only area that absorbs rural population on the frontier, or in Brazil as a whole for that matter (Torres 1990). It should be remembered that these high rates stem from an initially small base, representing relatively small absolute numbers. The total net rural migration for this area is on the order of 500,000 migrants, compared to approximately 16 million net urban migrants in Brazil in the same period (Wood and Wilson 1984, Martine 1987).

34. When considering the location of urban population growth, the uniformity is dramatic. The rates are very high in all frontier areas, without exception. The growth of rural population on the frontier is localized, but the growth of urban population is generalized.

35. We are therefore faced with a paradox. The regions of expansion of the "agricultural" frontier in Brazil, with exception of a belt passing through Rondônia, northern Mato Grosso and southern Pará, are losing rural population, while all are marked by accelerated urban growth. Thus it is now appropriate to speak of urbanization of the frontier. The following sub-sections focus on the vigorous growth of small and medium cities in the interior, especially in the context of pioneer settlement.

36. Urbanization of the Countryside in Brazil as a Whole. Urbanization in frontier areas should be understood in the context of the urbanization taking place throughout Brazil. In the 1970s, the proportion of the Brazilian population living in urban areas jumped from 55.9% to 67.6%. This population redistribution can be divided into two principal components, the growth of metropolitan areas and the growth of medium-sized and small cities in the interior, or "urbanization of the countryside".

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37. Table I-6 shows the percentage of the urban population of each region of Brazil living in cities over 100,000 inhabitants in 1980. The degree of primacy is not particularly high for Brazil as a whole or for the regions separately. The North and Center-West regions have higher degrees of concentration of the urban population than the Northeast and South. The North stands out as the only region in which the concentration decreased over time, over two decades.

Table I-6

Percentage of the urban population in cities with more than 100,000 inhabitants, by region, Brazil, 1950-1980				
Region	1950	1960	1970	1980
North	38.8	52.3	52.2	51.7
Center-West	-	12.6	41.4	48.0
Northeast	23.4	36.1	37.1	37.8
Southeast	46.9	49.5	55.1	56.2
South	22.2	24.3	29.5	37.0
Brazil	36.6	41.6	46.7	48.7

Source: Sinopse Preliminar, Censos Demográficos, 1950 to 1980, cited in Davidovich and Fredrich (1988:28).

38. The only officially recognized metropolitan region in the North Region is

Bel'em. For an analysis at a regional level, we could add medium-sized cities such as Porto Velho, Rio Branco, Manaus and Santar'em, which have functions different from smaller cities. Even though the growth of larger cities, because of their size, represents a large proportion of urbanization at the regional level, we see in the maps of growth rates that smaller cities are also growing rapidly, not only on the frontier, but also in the rest of Brazil (the higher rates on the frontier are principally due to small initial bases).

39. The explanations for "urbanization of the countryside" in Brazil, through growth of medium and small cities, have to do with broader economic and demographic trends. They include partial modernization of agriculture, the need of modern agriculture for urban services, new consumption patterns of Brazil's rural population, the need for urban consumer services, decreased access to land, and, finally, decreased access to ownership and employment in large cities. Each explanation is summarized below.

40. The partial modernization of farming practices in Brazil has involved mechanization in the preparation and cultivation phases and incorporation of chemical and genetic technologies, while harvesting continues to be done manually. This selective use of modern technology decreases the demand for labor during most of the year and increases it during the harvest season, due to higher productivity of land (Silva 1981). Technical progress also affects craftsmanship and services within farms, which used to be more autarchic, so as to decrease the occupation of the workforce in activities which are not directly agricultural and which could be performed in the off-peak seasons. Thus, selective mechanization accentuates the seasonality of demand for agricultural labor. A considerable part of the labor expelled from agricultural establishments remains in small towns and cities in the interior. These rural workers who are simultaneously urban residents are called "volantes" or "b'oiarias". The partial character of agricultural modernization is the fundamental

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economic explanation for this phenomenon.

41. On the traditional farm, services linked to production were developed largely within the establishment, but modern technology demands services of a sophistication and scale that can only be provided off the farm: machine and equipment maintenance, distribution of modern inputs, financing, technical assistance, telecommunications, etc. To this we can add services linked to consumption and to the reproduction of qualified labor (operators, technicians, administrators) who apply modern technology: schools, hospitals, supermarkets, leisure, etc. Urban services generate urban employment directly, as well as absorbing less qualified labor, such as bricklayers and washer-women, through multiplier effects.

42. In the 1970's and 80's the consumption "needs" of Brazil's rural population were redefined, incorporating a wide variety of industrialized products, including ready-made clothes, shoes and durable consumer goods. These consumer goods, which are perfectly transportable, are distributed in the commercial centers and markets of small cities and towns of the interior. In addition to the above-mentioned consumer goods, the rural population also seeks typically urban services such as education, health care, water, energy and television. In the current stage of development in Brazil, access to these services, which are not transportable and are collective, requires urban residence. The proliferation of urban nuclei and roads makes possible urban residence without total disconnection from rural activities.

43. Concentration of land ownership and the expulsion of permanent employees and sharecroppers, due to selective mechanization, have combined with the effects of labor legislation to restrict access to land, leaving urban residence the only alternative for a landless population.

44. Urbanization of the Countryside in the Amazon All the above-mentioned causes of urbanization of the countryside are present in the Amazon, although to different degrees. Some causes are accentuated because of regional peculiarities.

45. Although agricultural production in general is not as modern as in the South and Southeast, some activities such as black pepper plantations are modern except in the harvesting process. On the other hand, labor seasonality in extraction (of rubber or Brazil nuts for example) stems from a complete lack of modernization; preparation and cultivation do not take place at all, but only harvesting. In Amazo[^]nia, in addition to seasonality, we have to take into account the temporary character of deforestation: preparing the land for agriculture or cattle raising demands a great deal of labor, but during a short period of time. If they are from the region, the laborers who work in clearing are almost always urban.

46. Recruitment of male labor for rural activities in civil construction, deforestation or placer mining favors a sexual division between the countryside and the city.

47. New consumption patterns of the Brazilian rural population affect

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urbanization in Amazo[^]nia, as in the rest of Brazil, but the form of commerce deserves some comment. Previously, consumer needs of the Amazonian rural population were typically met by the "barrac[~]ao" trading posts, in the system of local monopoly-monopsony known as "aviamento". With the expansion of the road and communication network, the tight control of the "patr[~]ao" or boss was destroyed, and commerce multiplied. The large number of small businesses existing today in Amazonian cities and towns stems in part from the need for personal acquaintance between creditors and debtors in an unbureaucratized credit market. What is more, becoming a small businessman signifies a path to social ascension, or at least additional income, for many poor people.

48. Characteristics of Pioneer Urbanization. Recent pioneer urbanization can be classified according two three distinct types:

- a. **Company towns** - some nuclei are implanted by businesses to support the development of the company's own activities or as real-estate development projects. In the first case, we have Serra do Navio, Caraj[']as, Tucuru[']i, and Barcarena. In the second, Tucum[~]a (Butler 1985). Some cities mix support for the company and sale of land parcels and urban services.
- b. **Official towns** - official nuclei are principally those implanted by INCRA, the federal colonization and land reform authority, such as the "agrovilas" and "agropoli" of the Transamazon Highway (Smith 1982), the nuclei of colonization projects in Rondo[^]nia such as Ji-Paraná (Monte-Mor 1980) and Ariquemes (Wilson 1985), or Urban Nuclei for Rural Support (NUARs) such as Machadinho (Millikan 1984, Torres 1988).
- c. **Spontaneous towns** - Most nuclei are spontaneous, such as those that arose along the Bel[']em-Bras[']ilia Highway in the 1960s (Sawyer 1969). Others arose from agricultural occupation in areas without highways, such as Capit[~]ao Po,co (Sawyer 1979), or because of gold mining, such as Serra Pelada and Curionópolis (Pereira 1989) or Ouril[^]andia (Monte-Mór 1984).

49. There are combinations among the types. Nuclei also evolve, expanding from company or official origins to include spontaneous settlement, or being regularized through official interventions as occurred in Ouril[^]andia. There are also numerous cases of rapid expansion of new towns around older "seed" nuclei such as Marabá, Altamira and Ariquemes.

50. Even though the causes of urbanization of the countryside in all of Brazil, as detailed above, are essentially the same, with differences in emphasis, the effects are very different when we compare pioneer urbanization to urban growth in already occupied areas. Although growth in both cases can reach very high levels, with high absolute numbers in already occupied areas, the lack of a pre-existing urban base or of a network of consolidated cities creates special problems for pioneer urban nuclei. The growth near large cities or within an urban network - a simple extension of already existing urbanization - is fundamentally different from the implantation of new cities in the middle of the jungle. Peripheral urbanization is different from the urban periphery.

51. The principal difference is the overall deficiency of settlement in

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pioneer urban nuclei, as regards both population itself and public and private infrastructure.

52. Most of the frontier urban population lives in extremely make-shift and sub-standard conditions. Houses are usually self-built using easily available materials: unsawn wood, refuse from sawmills, mud and palm thatch. The floor is typically of earth. Recently, since about 1980, black plastic sheeting, often combined with palm thatch, has become the poor man's zinc. At times, wells and cesspools are dug for water and sewage. Otherwise, one appeals to neighbors, or to the streams and forests provided by nature. Either there are not sufficient wells and cesspools, or there is high risk of contamination, given the intense rainfall and porous soils. Dirty and stagnant water accumulates within the urban area, polluting the sources of water used for drinking, washing clothes, bathing ... Thus, living conditions, in terms of the house itself and its surroundings, are several rungs below those of peripheral neighborhoods of cities in southern Brazil.

53. The insufficiency of housing and improvements is due principally to poverty, which itself stems from the restricted access to land and employment, given the speculative character of the region's occupation and the weakness of productive activities. The effects of poverty are made worse by the transitory nature of frontier life. Many urban residents do not consider the city their permanent residence, but as eminently temporary. They may be waiting for land from the government, working at placer mining, have left their families while working in clearing or on some construction project. At the same time, the land titling process is dubious or nonexistent. Nothing is definitive. Thus, even when time or money are available, the deprived urban population invests little in housing or improvements.

54. Urban infrastructure is extremely deficient as well. This stems mostly from the rapid pace of population growth, which can reach 15% per year. Nuclei of 15,000 inhabitants, such as Xinguara (Godfrey 1979) appear in a matter of months. There is little time to install roads, lighting, water, sewers, etc., in the outlying neighborhoods, nor to build schools, health posts, hospitals, public buildings, etc., in the city centers.

55. Due to the lack of a consolidated central base, the problem of accelerated growth is worse on the frontier than on the periphery of large cities, where the growth rates might be equally high and the absolute numbers even higher. In the city centers or in neighboring cities, there are simply no collective services such as public hospitals, water and sewage systems and schools which might at least partially attend the recently arrived population. City governments, like the population, are very poor. They lack a basis for tax collection, which would make new public investments possible. They do not have enough officially enumerated population to receive proportional participation in federal funding. Agencies or companies responsible for water, electricity, telephone, transportation, and the like, do not exist or have very limited resources.

56. The deficiency of public services is exacerbated by the instability of urban growth, which has both ups and downs in frontier regions. Net overall urban growth for frontier regions includes some local decreases, if not in

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population terms, at least in industry, commerce, and other services. The "boom towns" of Amazoⁿia are better known than the "ghost towns", but these exist as well. Besides Beirad^o, Curion'opolis, Ariquemes, and Barcarena, there are also towns like Sena Madureira, Guajar^a-Mirim, 'Agua Azul and Manel^o, to say nothing of other urban areas which have disappeared completely. The state of Par'a, for example, has 14 district seats, localities considered urban by the criteria of the census bureau, which have a population of zero, an unsurpassable world record for the smallest "urban" populations (1980 Demographic Census).

57. The languish or demise of urban nuclei on the frontier is rooted principally in the transitory quality of the rural economic activities summarized above and described in greater detail in Chapter III. Some are transitory by nature, such as placer mining and lumber extraction through high-grading. Others, such as rubber extraction, could be permanent, but as peripheral activities with high transport costs, they are very sensitive to market oscillations and the continuance of government support. Other activities such as colonization, cattle-raising, or reforestation rarely succeed as stable industries, for combined economic and ecological reasons, and because they also depend to a very large extent on consistent political support.

58. Even when rural activities endure, the competition between incipient nuclei causes the weakening of some and the strengthening of others, or retraction at the local and regional level. In the first moments of occupation, numerous nuclei appear serving as construction camps, gas stations, highway junctions, river crossings, etc. With time, some settlements lose in inter-urban competition to others which attract stores, banks, hospitals, schools, electric plants, airports, telephones, television, post offices, hotels, and city governments. The differentiation process is cumulative, not only in terms of the economic activities and public services, but also in terms of migration. The construction or improvement of roads, although it can stimulate growth along its borders, can provoke stagnation in adjacent areas, where relative spatial advantages are eliminated (cf. Sawyer 1969).

59. Economic Basis for Urbanization One of the major questions is what sustains the urban economies, given that the rural economy seems to be so weak. It is therefore necessary to examine a series of issues.

60. In the first place, one must examine the agricultural economy. In spite of the "failure" of the majority of small and large farmers, there may still be a sufficient number that do produce enough to provide more of a base than the more visible unsuccessful migrants or investors might suggest. Colonization of the Bragantina zone in Par^a was decried as a failure (Anderson 1976, 1977), but it did produce significant wealth and did absorb many migrants (Cruz 1958, Pentead^o 1967, Sawyer 1979). Cattle-raising is denounced as unviable without fiscal incentives and land speculation (Hecht 1982, Hecht, Possio and Norgaard 1988), but many small farmers and medium-size ranchers are making profits (Monte-M^or 1989). Even if the proportion of newcomers who fail is high, the survivors may generate sufficient income to sustain the local economy.

61. In addition to farming and ranching, the activities that are expected a priori to drive the agricultural frontier, one must also look at non-

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agricultural activities such as timber and mining, particularly the garimpo. The income from these activities may be illegal or not be reported, but much of it is spent locally on mining equipment, diesel fuel, transportation, food, drink, entertainment and the services of prostitutes.

62. Finally, there are public and private transfers of various kinds. Government spending weighs heavily on the frontier, due to installation of new infrastructure, public works, settlement schemes, public sector employment, etc. Private investors bring capital in the expectation of production which may not occur. Finally, even poor migrants bring their savings from other regions and have to support themselves while they get set up, whether or not they are successful. All of these transfers, with current deficits, are based on expectations that may or may not be fulfilled. The boom mentality, or even the gamble or last resort strategies, stimulate the local economy. Whatever the final outcome, money is spent.

63. Final Considerations on Urbanization In the 1960's and 70's most of the migrants sought land of their own. During the 1980s, they discovered that their "project of autonomy" via land is generally not feasible in Amazon conditions, for a combination of economic, political and ecological reasons. They accumulated in the cities and towns because they were waiting for land or were pushed off it, or because they were unable to make a decent living with whatever land they had. In this sense, urban life was the only alternative for many migrants. Urbanization seems to have taken place without industrialization or any other kind of strong economic base.

64. Should "urbanization of the frontier" be taken as a sign of failure, undesirable, pathologic? Probably not. While the "push" factors behind rural-urban migration are undeniably important, one cannot forget the attractions of urban life. The new "push" factors act increasingly upon the urban population, now the vast majority in Brazil. The urban frontier attracts not only the rural folk who want or need urban services and comforts, but also urban population from the rest of Brazil. Many new migrants seek opportunities for employment or setting up their own businesses.

65. Demographic trends like urbanization of the frontier are the result of economic forces, but they also react back upon and alter or condition economic trends. The urban network of the frontier makes pioneer agriculture feasible for economic and social reasons, by providing productive and social infrastructure and the demand for agricultural production. Where the urban network is weak, the frontier is weak. Where it is vigorous, the agricultural frontier is strongest.

Stability of Settlement

66. Boom-bust cycles seem to have characterized Amazon settlement. Nonetheless, even though growth is not monotonic, it is not always explosive and it is rarely entirely reversible. The most stable communities (as distinct from stagnant) have developed in the Bragantina and Guajarina zones of Pará, in Southeastern Pará, along the Amazon, near Manaus and along the BR-364 road in

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Rondônia. This section focuses on factors that may favor stability and on out-migration from the Amazon.

67. Factors Favoring Stability The factors which may favor stability can be deduced in part from the foregoing review. They include:

- a. **Volume of migration.** The higher the volume, the more likely it is that other activities will develop because of initiatives of the migrants themselves (diversification) or because investors are attracted. There is also a demographic momentum, via social networks, favoring further migration.
- b. **Diversification of activities.** Spreading the risk among different activities helps smooth the boom-bust syndrome. In Tucumã-Ourilândia, there is a combination of small farming, garimpo, cacau, lumbering and ranching.
- c. **Economic infrastructure.** Transportation, communications, suppliers, services, etc. are fundamental for economic success.
- d. **Social overhead infrastructure.** Schools, hospitals, stores, etc. help retain migrants. Gaining municipal status, as happened in many communities, may contribute to this process, but not necessarily, if "emancipation" means that a federal or state agency such as INCRA or a state secretariat or a municipal administration can cut its costs, as seems to have happened in numerous cases, like Machadinho.
- e. **Permanent crops and investments.** Examination of the history of Brazil suggests that crops like sugar in the Northeast and coffee in São Paulo gave rise to vested interests which defended their properties and lifestyles or adapted them rather than abandoning their undertakings, as the "seringalistas" did following the bust of rubber, which involved practically no fixed investments.
- f. **Distance from markets.** The greater the distance, and therefore the greater relative weight of transport costs, the more vulnerable the settlement is to fluctuations in prices for inputs and products. The most peripheral settlements are the first to become uneconomical.
- g. **Low-cost technology.** Crops such as malva and manioc (cassava), which require practically no financial investment, supported large populations in the Guajarina zone of Pará.

68. Out-Migration. The frontier is normally thought of in terms of in-migration, but there are also various kinds of out-migration. As mentioned, more talented and educated individuals often migrate from the periphery to the center. There is now also considerable return migration. Data on out-migration, including return migration, are available in the 1980 census, but little analysis has been done. Migrants during the present decade are probably more likely to spread the word about disappointment and frustration on the frontier. The social process, via networks, that accelerated migration to the

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Amazon in the past, may reverse its direction in the future. This could also intensify the struggle for land in the South⁴. It would also weaken any official arguments that the Amazon is an alternative for solving problems in other regions of Brazil.

69. Just as there will probably be considerable population mobility within frontier areas, there will probably also be sizable inter-regional circulation as transportation improves and spatial friction decreases. Paved roads and direct bus lines facilitate movement back and forth. On the one hand, there is non-permanent exploratory migration to the frontier, as people look into opportunities there without having to make a once-in-a-lifetime jump in the dark (field interviews in Rondônia). There is also inter-regional seasonal circulation, such as garimpeiros who move from the Amazon to Minas Gerais in the rainy season⁵ or peasants from Ceará who harvest malva in Pará⁶

70. Locational Factors The prospects of different activities and their impact on migration and settlement are not just a matter of natural resources, world markets, availability of investment, etc., but, because of the interdependence outlined above, depend to a very large extent on location. Because of economies of scale and other economies of agglomeration⁷, such as use of common transportation, energy and services infrastructure (which are very unequally distributed in the Amazon) and circulation of money and labor among multiple activities, certain activities - including agricultural activities - will be very selective in their spatial location. A more random pattern of settlement, due to older settlement along rivers, new settlement in areas adjacent to the Northeast and Center-West, new roads, construction sites, free land, colonization projects, mineral deposits, timber resources, etc., will

⁴ - José Vicente Tavares dos Santos (1985a, 1987, 1988) has written about return migration and its effects on small farmers in southern Brazil. There is also personal information from various sources. Carlos Vainer reports that farmers along the Uruguai river facing relocation because of construction of dams refuse to go farther north than Paraná because "everything up there is malaria". Mark MacDonald found similar resistance while doing field work in Santa Catarina for his thesis at UCLA.

⁵ - Personal communication from Carlos Catão Loiola, Regional Director of SUCAM in Minas Gerais, 1988.

⁶ - Field observations in Capitão Poço, Pará, in 1975.

⁷ - In theories of industrial location, economies of agglomeration (Weber 1929) are like economies of scale in that larger undertakings have lower production costs, with the difference (Hoover 1937) that economies of location (external to firms and internal to the industry in question) and economies of urbanization (external to the firms and to the industry) are not internal to the firms, which can be owned and operated separately as long as they are near each other physically. See discussion in Ferreira (1989).

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probably give way to increasing polarization (Sawyer 1969).

71. A new element in this polarization is that rural activities will do best where urbanization is strongest and, to a certain extent, vice-versa. Agricultural location trends, analyzed by von Thunen, are no longer dissociated from industrial location trends, analyzed by Weber (1929), but tend to converge.

72. The areas in which urban and rural economic and demographic concentration will probably be strongest in the Amazon in the next decades are those in or around Belém, Manaus, Carajás and, to a lesser extent, Rondônia (Sawyer coord. 1990). New poles may emerge in other areas if new natural resources are discovered (as in the case of gas in the Juruá), if new agricultural technologies arise (as occurred in the cerrados) or if strong new policy incentives develop (as was the case in the past with colonization in Rondônia and the free port in Manaus).

73. Some of the other areas outside the main poles will grow rapidly but some will wane or grow slowly. In addition to "spread" effects, there will be "backwash" (terms from Myrdal 1968). The question is what makes initial settlement irreversible.

74. Political Factors This section includes discussions of the past, present and future role of the Brazilian public sector and of other political actors in defining patterns of migration and settlement in the Amazon.

75. Migrants to the Amazon since 1965 responded not only to long-term structural trends but also to policy incentives of the military regime. The cumulative and constant structural trends were rapid population growth in the post-war period and highly skewed distribution of income and property. The principal political factors attracting migrants were ambitious land settlement projects along the Transamazon highway, as part of the National Integration Program, and in Rondônia.

76. The migrants sought land or other means (placer mining, small business, etc.) to gain sustenance in the present and security for the future. Their search for autonomy, which ran contrary to the overall tendency of formation of a propertyless working class in Brazil, was contemplated and partially attended by official plans. Frontier migration served as an escape valve, at least symbolically, relieving pressures for land reform and other profound changes in the Northeast, Southeast and South of Brazil (cf. Velho 1976).

77. Present and Future Role of the Brazilian Public Sector. Present policies with regard to migration are very different. Colonization was officially deemphasized 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. The government of Rondônia now tries to discourage migration.

78. During the military regime, the prevailing view was that the laws regarding use of the Amazon were basically good (land statute, rural workers statute, protection of Indians, environmental legislation, etc.), but that there was insufficient political will to enforce them (CEDEPLAR/SUPLAN 1979, Perpétuo

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1981). However, the potential force of political will may have been overestimated. There are economic and demographic realities that do not respond readily, as well as strong juridical constraints. Ironically, a more democratic regime may have more difficulty making its will prevail.

79. Thus, while settlement of the Amazon was to a very large extent induced by public policies, intentionally or not, the existing situation has a rigidity in which the public sector can exercise only marginal influence. The fact that the State created the situation does not mean that the State controls it.

80. The extent to which control is possible or not must be studied in each case. While the federal government was all-powerful in the past, at least apparently, state and local governments have grown in size and sophistication and have more power and more revenues under the new Constitution. This is not necessarily a positive trend. Decentralization may be disastrous for the environment and for small and vulnerable groups like Indians and traditional extractors. Local governments depend on local resources (i.e. "development") and have little power or ability to regulate negative social or environmental consequences. At the same time, they may be more sensitive to the needs of their electorates. In addition to promoting or regulating development projects, they also spend the tax revenues, which may or may not be used for the benefit of disadvantaged segments of the population.

81. There is a view that a populist regime in Brazil would invest more in the Amazon than an authoritarian regime (ELETRONORTE 1989). However, while such an administration may spend more on the Northeast, which has 30% of the country's voters, it would probably spend less in the Amazon, which has only 5% of the voters.

82. At the same time, any type of regime would invest in the Amazon in order to make money and solve national problems, as was the case with interventions in recent decades. The lesson seems to be that investments in the Amazon waste money and create new problems (Gasques and Yokomizo 1986, Yokomizo 1989). This makes massive investment unlikely under any political scenario.

83. Consequently, 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.

Concluding Remarks

84. The following general scenario can be ventured with respect to the demographic dynamics of the Amazon. Inter-regional migration will contribute less to regional population growth than in the past and natural increase, with a

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larger initial base, will contribute more⁸. There will be more migration from the Northeast and less from the Southeast and South. The socio-economic composition of migration to the region will probably change in such a way as to increase the participation of qualified and educated groups from the latter regions.

85. Redistribution of population within the region will favor the principal poles (Belém, Manaus, Carajás, Rondônia), in which both urban and rural population will be concentrated. There will be intense mobility within the region. The peripheral areas will remain relatively empty, with indigenous and local populations, including migrants left over from previous peasant frontiers.

86. The level of urbanization will probably increase in all parts of the region, reaching an average of around 70% by the year 2010 (Hakkert 1990). Thus, urban population will grow more rapidly than the total population. More than half of the urban population will reside in the capital cities and the rest in small and medium urban centers, many of which will be new, in the interior.

⁸ - Hakkert (1990) shows that the North Region has rates of natural population increase (fertility minus mortality) double those of more developed areas of Brazil. In the 1970s, the Amazon population grew at approximately 3.7% per year, while population of the Southeast and South grew at approximately 1.9% per year. Thus, no matter what happens with net migration, the North region will increase its share of the total population of Brazil. The extent of this increase depends on the velocity of the fertility transition in the different regions.

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Annex II
Logging and Wood Products

87. Introduction. Logging and lumbering play a key, strategic role in the current pattern of exploitation of the Amazon, primarily through opening access to previously inaccessible lands. This role has been encouraged by both a range of public policies and, during the early 80's by an extremely strong hardwood market. Despite a worldwide glut in mahogany in 1985, the medium-term prospective is for increasing international pressure to be put on South America's tropical forests.

88. 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 become 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.

89. In Brazil in 1975 only 4.5 million cubic meters (M3) or about 14% of national 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 M3, or 54% of the Brazilian total (Table II-1). 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,

Table II-1

Log Production in Major Geographic Regions of Brazil, 1975-1984
(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, Anuario Estatístico, various years.

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fiscal incentives, and a sharp rise in international hardwood prices.

90. A key question with logging, as with the other fundamentally extractive activities in the Amazon, is whether or not the social benefits resulting from the opening up of the forest outweigh the social costs. As we shall see, logging is often the first stage in a process of shifting, primarily extractive, agriculture⁹. In many cases it is a vital complement to farming and cattle ranching: as logging advances into the forest, subsistence farmers soon follow. As soil fertility declines these farmers move forward, following the access provided by loggers. If they have managed to acquire land title, they will often establish pasture and sell the land to the ranchers who follow. In this way timber is a vital step in the process of mining the nutrient stocks of the Amazon; a process that begins with logging, is followed by annual cropping, and generally ends with ranching.

91. Depending upon the ability of the community to diversify into additional economic activities, this process may or may not generate sustainable communities in the Amazon¹⁰.

92. This section reports first on the history and growth of logging in the Amazon and the role of government in its promotion. It will then describe in some detail its role in the economies of several communities in the Amazon. Finally it will evaluate some environmental implications of current practices, analyze the economics of the policy environment, and make recommendations for future policies.

93. Typology of Lumber Operations in Amazonia. Historically timber extraction in Amazonia was concentrated along a narrow strip of flood plain (varzea) due to the almost total lack of roads. 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 still represented the primary means of wood transportation, with 68% of the log volume used by industries coming in this form (Nascimento 1985).

94. With the opening of access through road building and frontier development, lumbering is currently taking place in all major frontier areas of the Brazilian Amazon; particularly in Para and Rondonia. As the Amazonian wood industry evolves, different types of lumber operations have developed. These operations can be classified according to the ecological niches they exploit (river

⁹ This use of the word extractive implies nonsustainable mining of the nutrient base of the Amazon.

¹⁰ From the point of view of social welfare, the vital question is whether the productive potential created by the mining of the Amazon is worth more or less than the intact forest it replaced. It should be noted that to be socially beneficial new productive potential resulting from extraction in the Amazon need not be created in the Amazon. It could take forms as diverse as factories in the Northeast (or Sao Paulo) or investment in human capital through education.

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floodplain vs upland), their degree of capitalization and technological sophistication, and their proximity to other economic activities.

95. In general, the economics of forestry in the Amazon dictate that the poorer the access to markets and to labor, the more selective will be the harvest. Para, the Amazon's largest wood producer, provides the following examples:

a. High Grading in Remote Areas. Far from urban centers in frontier forest areas that have been reached by road only relatively recently, highly selective extraction dominates. This pattern, called "high grading" focuses on only 2 or 3 species (including mahogany) which bring a high value on the international market. Because of their remoteness, these lands are generally sparsely populated, allowing the lumber companies relatively free reign. South central Para is an example of this type of lumber zone. Here, about a dozen large, mechanized, companies, largely from Parana, dominate the industry.

b. High Grading in Intermediate Areas. In the central portion of Para, near the communities of Tailandia and Goianesia where large numbers of small farmers have settled relatively near the state highway (PA 150), small and medium lumber operations equipped with chainsaws selectively extract about 15 wood species (Uhl draft, 1989). Uhl also reports different levels of capitalization in sawmill operations ranging from small operations to a few large plywood operations.¹¹

c. Areas with a Developed Wood Industry. In eastern Para (Paragominas area) there is a less selective exploitation of about 100 species. Many larger sawmills are increasingly vertically integrated allowing for mechanical extraction and processing locally. Over the last 5 years, plywood companies from southern Brazil have established operations here. This has resulted in greater efficiency and utilization of wood with the exploitation of logs of second and third quality. Supporters of the local wood industry see this as a good sign since it adds more value within the state boundaries and results in a more complete utilization of forest resources.

d. Flood Plain Logging. The wood industry in Amazonia can also be distinguished according to the different environmental niches exploited. Para is currently experiencing a heavier exploitation of wood in the varzea

¹¹. Uhl's 1989 survey of 48 sawmills also reveals distinctions in terms of levels of capitalization. In the Tailandia area he notes the following classes of sawmills: 1) 13 mills are small with between 40 and 180 m³ per month relying primarily on old equipment and producing poorly cut wood so that their products are limited primarily to the internal market. 2) 31 of the mills are of medium size producing monthly between 100 and 680 m³ utilizing more modern machinery. Finally, there are three large mills: one is a sawmill/laminadora (plywood operation) with a monthly production of 750 m³; the other two are simply sawmills.

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(floodplain) which offers the advantage of easier tree removal during the period of high waters¹². In the varzea there are often fewer species overall with the available species occurring in more dense concentrations making their exploitation easier than in upland areas. This greater natural density justifies the exploitation of species that might be considered of inferior quality where extraction is more difficult (remote upland areas). In northern Para along the varzea areas around the island of Marajo, sawmills of all sizes focus on the extraction of virola, a wood of lower quality that is used extensively for moldings, lamination, and plywood (see Uhl and Viera 1989).

96. Government Promotional Policies. Following the 1964 coup, a variety of efforts (promoted by different military presidents) were implemented 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, and for timber export. Independently of official policy, 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 the entrepreneur.

97. Support to the domestic wood products industry has been through SUFRAMA (Superintendency for the Manaus Free Trade Zone) and SUDAM incentive programs. SUFRAMA approved 19 projects in wood products between 1968 and 1975, with an investment of US\$ 53 million, or 11.3 % of the total projects it approved (including electronics, metallurgical, chemical, and food processing). The wood products projects financed through SUFRAMA employed 3,747 people out of a total of 26,154 individuals employed overall as a result of SUFRAMA project promotion (Mahar 1979:155). Lumbering was also officially promoted by SUDAM as part of the second Amazon Development Plan in 1974. By 1976, SUDAM had approved 17 new projects involving wood products and the expansion of 6 projects for a total investment of US\$ 144 million (see Mahar 1979).

98. Promotional programs for exporters of wood products are were substantially more important than those for the domestic wood products industry. In 1967, the Brazilian Government established a subsidy program for exporters which included 1) corporate exemptions for certain value added taxes and import duties and 2) subsidized loans to exporters. As part of this general export promotion policy, the Central Bank of Brazil established in 1980, two lines of subsidized credit, one for producer-exporters and the other for trading companies.¹³

¹². Varzea sawmills double their wood production during the wet season. The reverse is true for lumbering in the upland areas where tree removal becomes almost impossible during the rainy period due to the condition of the feeder roads.

¹³. Participants were expected to maintain their previous year's level of exports during the financed year and were assessed nominal financing charges at a rate of 40% per year when nominal commercial short-term rates exceeded 150%.

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99. One principal difference between the two credit lines was that trading companies were eligible to receive much larger loans (equivalent to 50% of their liquid assets). In a 1983 study examining a sample of trading companies and producer exporters representing 88% of mahogany exports during that year, Browder found that the average trading company obtained \$1.1 million in subsidized loans over the period 1982 and 1983, while the average producer-exporter received \$681,000. In 1982, the value of subsidized export loans and related services (in all sectors) was approximately \$9 billion.

100. Although Browder (1987) emphasizes the diversion of these funds to overnight money market accounts¹⁴, the combination of these fiscal incentives and an attractive world market price led to an extremely rapid growth of the lumber industry. By 1983 mahogany represented over 30% of all Brazilian lumber exports. By 1985, however, foreign markets had become saturated with Brazilian mahogany causing prices to fall dramatically and leaving many producers in debt to the trading companies that had financed their activities.

101. The direct government promotional programs reviewed above have tended to favor highly-capitalized operations and large buyers. The most consistent encouragement to all sectors of the lumber industry, however, has been the relative freedom with which it has been allowed to exploit the public forest resources through near total absence of forestry management guidelines or enforcement of existing regulations. This situation has been exacerbated by the numerous agencies (state and Federal) charged with different aspects of forestry supervision and management as well as the low levels of human and capital resources allocated for the task.

102. The Lumber Industry and Frontier Development. In its most traditional form, logging is a classic extractive economy. It can create temporary booms in economic activity, spurring frontier development for a time, but when valuable hardwoods are depleted locally, sawmill and logging operations simply move on to new areas. This type of boom-bust situation was particularly acute during the mahogany boom of the early 1980s. During this period, numerous small frontier communities, from southern Para to Rondonia, grew as a function of intensive mahogany exploitation.

103. Browder (1987) documented the effects of the mahogany boom in frontier Rondonia. In the late 1970s, before the arrival of large trading companies spurred on by Brazil's subsidized export financing program initiated in 1980, the lumber industry in Rondonia was comprised of a diverse network of small farmers, independent loggers, truckers, and small-scale mills.

(Browder 1987).

¹⁴ Nominal interest on overnight funds during this period was on the order of 100% interest annual, compared to 40% interest charged for the export credit line. There was also incomplete monetary correction on the credit line, allowing further gains to borrowers as the value of the principal declined.

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104. With the advent of export financing, the industry became attractive to major trading companies. Exporters were interested in high volumes both because of the demands for international export and because the export promotion program rewarded subsidies in fixed proportion to the volume of foreign sales. Consequently the trading companies rapidly established large, mechanized logging operations on tracts of untitled federal forests. Initially, these "self-asserted territories" were protected through a system of armed checkpoints. Following the exploitation of these public areas for available mahogany, the trading companies entered restricted areas, including indigenous and biological reserves.

105. According to Browder (1987), in 1980, only 6 mills operated in the town of Rolim de Moura (Rondonia) with a production of about 12,860 m³. By 1984, there were 34 lumber mills in the same community employing 47% of the working population with an output of nearly 100,000 m³ (80% of which was mahogany). The rate of increase in mahogany log prices between 1980 and 1984 exceeded by a factor of 2.3 to 1 the rate of growth in value of Brazilian treasury bonds (ORTN), on which US dollar exchange rate and domestic price adjustments were based. The boom turned to a bust in 1985, however, when export prices fell by 24%. By July of 1985, mahogany accounted for only 23% of the community's sawnwood production. In Rolim de Moura, the community and most of the sawmills survived the bust by turning to more diversified domestic market production.

106. 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 (see Sawyer coord. 1990: 82-96; Uhl, 1989). In general, the frontier lumber industry provides limited amounts of needed supplementary income and infrastructural services to agricultural colonists, ranchers, and fledgling municipalities.

107. Ranching and lumber activities enjoy a particularly close relationship in some older, more developed areas of the Amazonian frontier. The Paragominas area of eastern Amazonia is one such area. Here the wood industry has progressed to a more capitalized stage justifying the exploitation of a wider range of species. At the same time, the local ranching industry has seen its first generation pasture grasses decline over the last 8 to 10 years. If these pastures are not recuperated, they are usually taken over by weeds and abandoned.¹⁵

108. The dramatic reduction in availability of government subsidies for new ranching activities has also increased the need for alternate sources of income, further increasing the importance of lumbering as a major form of diversification in the region. In the absence of credit, lumber sales also help ranchers to underwrite the cost of installing improved pastures. In addition, in some cases, lumbermen have begun to acquire land as "ranchers" to avoid the

¹⁵. Uhl (1989 draft) estimates that 100,000 square kilometers of forest in Amazonia have already been converted to unproductive pastures.

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complicated environmental impact statements (RIMA) now being required.

109. Case Study of Tailandia, Para A well documented case in central Para shows how a variety of lumber operations and activities have become linked to the livelihood of small farmer settlements near the community of Tailandia. This case provides an example of the development of a local wood industry as former frontier areas become better established.

110. The state highway (PA-150), completed in the mid 1970s and paved in 1984, brought a hungry lumber industry into the area.¹⁶ In 1978, Para's state land agency (ITERPA) attempted to settle approximately 3,000 landless farmer families on plots of 50 ha. in an area totaling 158,400 ha. Today Tailandia has 30,000 inhabitants, most of whom have arrived within the last two years in search of work. Sawmills are the biggest employers in this area¹⁷.

111. Of the two principal groups in the area (ranchers and colonists), the colonists were the first to benefit from the sale of wood since their lots were closer to the highway. Although the majority of the ranchers (60%) sell some wood, the amount is still small since many appear to using it as a store of value¹⁸.

112. In this areas, most small farmers practice subsistence agriculture with almost no use of commercial inputs. In the 1987-88 agricultural year, 52% of the sample of 242 small farmers colonists reported that they did not derive enough income from agriculture alone to survive. Consequently, they participa-

¹⁶. In January of 1989 along the length of the PA 150 (from Tome Acu to Goianesia) there were a total of 48 sawmills. Between 1978 and 1985, before the paving of PA 150, a number of small sawmills installed themselves in the area but many apparently ended up closing. After the paving of the PA, sawmills arrived in larger numbers transforming Tailandia into a pole for wood exploration. Fully 70% of the sawmills found in the area today came here after 1986 while 17% have installed themselves in 1989 alone (Uhl draft 1989).

¹⁷. A group of researchers from IDESPE, Museu Goeldi, and EMBRAPA (led by Chris Uhl) are attempting to document the social, economic, and environmental effects of selective lumbering as it is being done today in Para. The following figures are based on a survey they conducted in the Tailandia area in 1989.

¹⁸. By 1989, cattlemen, who have much more land to exploit than farmers, had only cleared about 10% of their land for pasture (Uhl draft 1989). In addition, the better-off farmers and ranchers (the 2.7% that owned 14.4% of the land) were able to invest in cattle, black pepper, passion fruit and food crops, as well as purchases of forested lots for wood.

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te in various stages of the lumber industry (location of trees, extraction, transportation, and sawmill work) in order to augment their household incomes.

113. Many of these small holders, simply sell wood off their lot receiving in return goods (tools and traction animals), services (clearing of land with chainsaws), and cash. In 1988, 16% of these colonists listed lumber as their principal source of income. In 1989, about one quarter of colonists were using the sale of wood from their plots to become increasingly involved in lumber. Uhl (1989) found that 70% of the small farmers in the sample had experienced some sort of lumbering and one third had completely logged their plot.

114. Farmers who sell wood from their land generally receive about 1% of the value of the sawed wood, while the intermediaries get 28% and the sawmills 71%. The price of the average standing tree of redwood is \$5, the tree cut down but still a log is \$18, while the log sawed up is worth \$90. Uhl states that sawmills are generally able to yield 2 m³ of sawed wood from 3 m³ of wood in log.

115. 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. Unfortunately, lumber roads are often poorly built resulting in significant maintenance costs.

116. Of the 272 km of feeder roads built within the agricultural colonization project described above, 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 ITERPA¹⁹.

117. Lumbermen report that the cost of buying the wood from farmers represents only 17% of their total costs²⁰. Most come from Brazil's South region (Parana, Santa Catarina, Rio Grande do Sul, and Minas Gerais), where over half of them did similar work. Land is still cheap in Tailandia allowing over half of the lumbermen interviewed by Uhl (1989) to buy up land for lumbering and other agricultural pursuits. Thus there are lumbermen that are becoming more involved with agriculture and colonists who are moving toward becoming more involved with lumber.

¹⁹. Small farmers that abandon farm plots often give lack of good feeder roads as a principal reason for their action.

²⁰. These are mainly middlemen who extract logs for larger sawmills. They may also buy from lumbermen who only have a chainsaws but no truck. When these "chainsaw lumbermen" have already cut the wood then the middlemen who haul the wood to the mill divide their profits 50-50 with the "chainwaw lumberman."

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118. Forestry Plantations Extensive single species plantations in tropical forests (such as the large oil palm plantations in the Ecuadorian Amazon) have been criticized by ecologists because they eliminate the diversity of the native forest. Even when species native to the region are used, many large-scale efforts have ended in failure. Early attempts to develop rubber plantations in the eastern Amazon in the 1920s (by Henry Ford) failed for a number of reasons including problems of labor scarcity and diseases affecting rubber stands.

119. It is now generally agreed that rubber plantations generally fares better outside of the Amazon region. The significant spatial distances that separate trees of the same species in the natural forest that makes harvesting so difficult also helps control the spread of pathogens. For this reason, any single species plantations of trees native to the region are a considerably greater risk of pest problems.

120. More recently, the Jari pulpwood operation planted large stands of several fast-growing varieties of trees (*Gmelina arborea*, *Pinus caribaia*, *Eucalyptus* spp.) to use as raw material for its pulp operation. Jari, the largest silviculture operation in the Brazilian Amazon, was a 1.6 million hectare area project started in the late 1960s by the American billionaire Daniel Ludwig (Universe Tankships Corporation). In 1982, Ludwig sold the operation to a consortium of Brazilian companies.

121. When Ludwig pulled out, the project (which also included ranching, water buffalos, irrigated rice, caolin mines, and a saw mill) the project was branded a failure. Many of the initial plantations had to be replanted because they were not well suited to the areas first selected. Only in 1986, almost 18 years after it started, did Jari show a profit (Fearnside 1987).

122. Although the Jari pulp production effort appears to be profitable today (Arnt 1989 cited in Sawyer 1990 consultant report), the effort is not likely to be replicated elsewhere in the Amazon (see Fearnside and Rankin 1979, 1985). The two reasons usually cited are that the start-up costs are quite high and that tree plantations are probably more competitive in other part of Brazil, outside the Amazon

123. Charcoal Production for Smelting of Pig Iron. In a project announced 8 years ago, the Brazilian Government began to implement the installation of 13 pig iron mills to serve the Greater Carajas Project. These pig iron mills were to initially use charcoal produced from natural forest areas in Maranhao and Para States. Environmentalist have consistently condemned the scheme because of the deforestation it entails. (see Anderson 1989; Valverde 1989 cited in Sawyer 1990 consulting report; OED 1990).

124. The Nossa Natureza Program, announced in April of 1989, requires the companies deforesting the area to replant the trees. In addition, IBAMA requires that companies using more than 8,400 m³ of wood a year supply 40% of their own stocks. By 1995, this requirement will become 100%, though an exception will be made for companies engaging in reforestation who may continue to purchase 20% of their charcoal from other firms.

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125. Although the economics of destruction of intact forests to create charcoal is questionable, it should be pointed out that many farmers simply burn or abandon all the wood on their plots to make way for agriculture. In many areas, charcoal represents one commodity small farmers can produce with little effort. This issue, closely linked to the development of the Carajas Iron Ore Project, is discussed in greater detail in that section of the report.

126. Environmental Criticisms and Current Logging Practices. 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, emphasises 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.

127. With appropriate economic incentives, logging can stimulate the growth of the remaining trees rather than damage them. Whether or not sustainable forestry techniques will be adopted depends upon the relative cost of acquiring new land and that of adopting sustainable techniques on existing land. As mentioned above, in the Amazon the economic incentive for sustainable agriculture of any type is limited by the seemingly endless supply of virgin land²¹. In the specific case of timber, this takes the form of the relatively high cost of labor and transport when compare to stumpage costs. According Uhl (1989), selective logging rights on a hectare of forest in Paragominas (which typically removed four to eight trees per hectare) varied from US\$ 25 to US\$ 50 per hectare 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.

128. The result of this large relative cost difference is the extremely selective logging patterns observed in the remote areas, which minimize machine and labor costs per unit value of timber extracted, as well as lack of concern over the condition of rthe post-logged forest. This inevitably results in the loss and/or damage of many potentially valuable hardwood species (as well as those with unrecognized value) by what appears to foresters as 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: Regiao Norte, 1977:377).

129. In general, the less selective (and more intensive) the extraction, the greater the damage to the standing forest. In Tailandia, for example, 40 m3 of

²¹ This statement should be qualified to reflect the fact that access is required to make the land economically viable.

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wood is lost per hectare through damage by removal of other wood. Seen another way, if there are 495 trees (greater than 10 cm) in a hectare of forest, after typical extraction, up to 64 (13%) of the trees are damaged (Uhl 1989 Draft). In Paragominas, where more intensive extraction techniques are employed, 26% of the trees can be damaged or killed²² with the logging of one hectare of forest (Uhl 1989).

130. Clearly at these relative prices of stumpage and extraction costs, the economics of more careful extraction looks unpromising to the logger. As with the farmer and the rancher, low land prices lead to extensive techniques of production. In the absence of a clear policy with respect to costing environmental externalities, however, there is little economic justification for imposing "environmental" controls on extraction activity. In the Paragominas area the benefits are particularly doubtful, considering that the likely fate of the remainder of these selectively logged areas is clearcutting for charcoal production and pasture.

131. Improved Logging Techniques. For areas where it is determined that maintenance of forest cover is a high social priority (for instance to protect watersheds or to maintain target levels of biodiversity), least cost techniques may involve sustainable forestry. A number of techniques are available, although their economic viability under Brazilian conditions would have to be established.

132. 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 and remove valuable trees so as 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).

133. Building on the concept that controlled forest clearing can stimulate growth, a technique has been developed called the "strip shelterbelt system"²³. This effort was tried with some success in the Palcazu Valley of the Peruvian

²² Trees are damaged or killed in various ways from the extraction process. A small percent are cut down but then not removed and left to rot. Others have their trunks damaged. A significant number of those damaged have their canopies destroyed, while others are knocked down by tractors used to extract the valuable timber (Uhl and Vieira 1988).

²³. 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.

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Amazon in a project with Yanésia Indians supported with funds from USAID²⁴. 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 logging road. Estimated yields of 250 m³ of wood per hectare is a substantial improvement over the 5 m³ 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 with local and national markets only.

134. The economic merits of these techniques have not been established under Brazilian Amazonian conditions. In view of the low cost of Amazonian land, it is quite certain that the return to land, labor, and capital would not be maximized by more labor-intensive, sustainable techniques. In view of the relative costs of land and other factors as discussed above, however, it is doubtful that they could compete with current land extensive, extractive techniques.

135. Past Policies to Regulate Forest Exploitation. Policy discussions concerning regulating forest exploitation has suffered from two basic shortcomings. The first is that the proposed policies have ignored the economic incentives to continue the current land-extensive techniques. The second is that the objectives of proposed forest management policies have never been made adequately clear.

136. 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 upon this model was the Pandolfo Proposal (Nascimento 1985) by SUDAM (1977) intended to "rationalize" wood exploitation in Amazonia.

137. The Pandolfo program, which was never actually implemented, represented the first official proposal for federal government forest policy for Amazonia²⁵. 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

²⁴. 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.

²⁵ 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 Amazonia, despite a request for such a proposal during the Figueiredo Administration (Projeto de Lei no. 4970 de 1985).

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plan envisions the creation of a 50 million hectare network of national forests in Amazonia (called Florestas Regionais de Rendimento) for managed concessions (see Nascimento 1985; 1989).

138. In support of this plan, in 1978, IBDF completed a study concerning the establishment of a system of contracts governing the private exploiting of public lands in Amazonia. This study recommended 10-20 year forestry concessions to private companies to exploit the forest under specific management conditions and under government supervision. Despite the availability of SUDAM fiscal incentives, however, little interest was shown. Although Nascimento (1985) credits the greater attractiveness of fiscal incentive programs for cattle, it is more likely that as long as access to new land is cheap it is impossible for loggers employing sustainable forestry techniques to compete in the same market with others using extractive techniques.

139. Additional evidence concerning the lack of enthusiasm for sustainable forestry techniques is given by Binswinger (1979). He notes that tax credits provided by IBDF to corporations who agree to undertake reforestation have resulted in extremely little new planting. Recipients of tax credits (for both ranching and reforestation efforts) were far better "at receiving tax credits than at producing beef or planting trees".

140. Future Policy Requirements for Amazon Lumber Activities. Central to defining appropriate land management policies is a clear conception of the objectives of the policies. In large measure the implicit objectives of past policies has been to replicate techniques that have proved to be economically optimal in countries that have very different factor proportions, and, therefore implicit (and/or explicit) factor prices. The manifest inappropriateness of these techniques (to loggers and local authorities) within the context of Brazil's very different factor proportions is probably the major explanation for the lack of enthusiasm for their application

141. Land management policies in Brazil should focus on outcomes, not on land management techniques. The central question remains that of defining first, the externality that justifies market intervention, and second, minimizing the (opportunity) cost of obtaining the given social objective.

142. As reviewed in Chapter I, the major justification for market intervention is to protect the world's stock of genetic resources. Clearly policies with this objective would be very different from forest management policies designed to make Brazilian logging practices resemble more closely those of the United States. 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 required 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.

143. A clear policy must also be determined with respect to logging in Indian

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areas. Although technically illegal according to the Indian statute, logging has been documented within the territory of at least 8 different groups²⁶. Logging in Indian lands has resulted in 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.

144. The Public Finance of Enforcement. Enforcement of Forest management restrictions poses a serious problem of tax competition among various local and state governments. Restrictions on 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 be lax in the enforcement of such legislation, especially in view of the high degree of mobility of the timber industry. Thus the potential for competition among various localities for the forest industry is likely to quickly erode efforts to impose strict regulatory measures. This is especially important in view of the other quasi-public benefits the industry brings to local government, especially road clearing.

145. Although it might be thought that local government would have a particularly high stake in the sustainability of regional economic activity, it is likely that given the time horizon of most local politicians, unsustainable forestry, which generally implies a progression of farming and ranching activity, is viewed as a good thing. In a sense, a 20-30 year boom, during which period the nutrients of the virgin ecosystem are mined, is perceived as preferable to a sustainable trickle.

146. This lack of incentive for enforcement probably goes far to explain the current manifest lack of enthusiasm for taxing and regulating the 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 are to 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 generally poorly staffed and subject to circumvention by the use of 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. A law prohibiting the export of whole logs has had little impact on the lumber industry in Amazonia since logs of export quality are now cut into three or four large pieces before they are exported.

147. Despite a greater concern for environmental issues as expressed in the Nossa Natureza Program and the creation IBAMA, resources devoted to enforcement of logging activities are only token and policy commitment continues to be

²⁶. Logging has been reported on the lands of the Nambiquara, Cinta Larga, Surui, Gavião, Arara, Kayapo, Guajajara, and Tikuna. For more information see Greenbaum, "Plundering Timber on Brazilian Indian Reservations" in Cultural Survival Quarterly, 1989, Vol. 13 (1).

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relatively absent at the local level²⁷. In addition, state and federal responsibilities have not been clearly delineated. Although recently the first president of IBAMA (Fernando Mesquita) threatened to shut down numerous sawmill operators in Manaus if they failed to submit management plans for recuperation of degraded areas or detail the source of their lumber, IBAMA at the local level still does not have the staff to process those seeking to show intention to comply. During a recent mission to Brazil (12/89) it seemed that IBAMA is so understaffed in Para that it is able to attend to only a fraction of the applications to clear land in Para.

148. In addition, there are numerous ways to circumvent greater regulation. An example is the recent requirement that a RIMA (environmental impact statement) be submitted for logging on areas over 100 hectares. By registering with IBAMA as a rancher rather than a lumber operation, this requirement is raised to clearings of over 1,000 hectare. Although lumber companies are currently required to obtain operating licenses (guias madeireiras), they are rarely punished for failure to produce these during inspections of their operation.

²⁷ 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 represented about 1,600,000 km².

**Annex III
Small Farmers and Settlement Schemes**

149. Introduction. The small farmer is an essential agent in the dynamics of the exploitation of the Amazon. As we have discussed above, in the current process, which is essentially one of extracting the nutrients from the Amazon, he is key economic complement to logging and ranching. This process is essentially mobile, and its economic viability depends critically on availability of new, cheap land. This mobile nutrient mine will stop only when small farmers can make a better living through (geographically) sustainable agricultural techniques than they can through mining the nutrients from new land and forest.

150. The realization that Amazon soils and growing conditions are generally poor has come about only over the last decade, following the disappointing results of public and private colonization schemes over the 70's and 80's. 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 to only a select few.

151. This section will first, briefly review the economic incentives to migrate to the Amazon. Second it will review the history of colonization projects in the Amazon, including various land tenure issues. Finally, it will discuss the adoption of sustainable techniques.

152. The Incentives to Migrate. As discussed in Annex I, farmers migrating to the Amazon came from two quite different groups: generally poor, and generally landless farmers from the drought prone Northeast, and relatively better-off small farmers from the South. Farmers from the Northeast have moved under the stress of drought and poverty. Those from the South have been much more influenced by the rising value of land in the South relative to the North. For small southern farmers witnessing an increasingly steep land price gradient (see Chapter I) a clear incentive existed to sell off to larger farmers hoping to capitalize equipment purchases over larger areas. Many chose to take the proceeds from these sales and to invest in cheap land in the North²⁸.

153. In addition to these factors pushing migrants to Amazonia, both public and private settlement schemes actively promoted the region. Many projects were

²⁸ In a description and analyses of the various types of migrants to the Amazon, Anna Luiza Ozorio 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.

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initiated with much fanfare, which often included TV and radio spots as well as printed brochures extolling the advantages of farming in Amazonia and down-playing or obscuring the region's risks (including poor soils and rampant malaria²⁹). 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 through official campaigns of dissuasion. Nevertheless, as southern migrants gradually become aware of the many problems of frontier life, and as the national economic crisis worsened, the volume of migrants arriving to many frontier destinations has declined (Chapter II, Martine 1981, Sawyer 1984).

154. Agricultural settlement and titling efforts in the Amazon have succeeded in providing titles to 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 expulsions of peasant farmers (Mougeot 1985)³⁰.

Amazon Agricultural Settlement Programs.

155. 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 Amazonia, the Private Colonization initiative (northern Mato Grosso and south central Para), and the semi-directed settlement efforts in Rondonia. Each of these projects has been associated with broader policy initiatives (PIN, POLONOROESTE, POLOAMAZONAS, Grande Carajas Program) that sought to develop the region and integrate it with the rest of the nation.

²⁹ 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 Rondonia 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 special 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.

³⁰ In Para, for example land holdings of 1,000 hectares and larger account for 0.7% of the landowners but occupy 51 % of the agricultural land (Hall 1987).

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156. Transamazon Colonization. The Transamazon Colonization effort, announced in 1970 as part of the first Program for National Integration (PIN), remains one of the most ambitious government efforts to settle farmers in the Amazon region. The Transamazon effort received a great deal of publicity in Brazil, beginning as it did with an announcement by then President General Medici that the project would "bring men without land to a land without people." The men without land were the drought stricken poor of the Northeast.

157. The major objective of PIN was to promote a greater economic integration of Amazonia with the rest of the country and (in particular) the Northeast. The Transamazon colonization effort specifically sought to promote the development of stable and productive agricultural settlements in the region while reducing land ownership tensions associated with land concentration elsewhere in Brazil by attracting the landless to the Amazon³¹.

158. Colonization efforts were based on the new program of road building, with the Transamazonica (Transamazon Highway) as the principal artery. Over US\$1 billion was allocated for fiscal years 1971-1974 for the construction of the 2,475 km Transamazonica and the 1,500 km Cuiaba-Santarem and the development of associated agricultural colonization on a 10 km-wide strip on each side of these roads. A new agency, the National Institute for Colonization and Agrarian Reform (INCRA), was created in 1970 to implement the effort.

159. Further legislation created PROTERRA (Program for Land Redistribution and Incentive for the North and Northeast Agroindustry) with a proposed budget of US\$ 1.75 billion for: a) operational and compensation costs for expropriated lands to be resold to small farmers, b) credit for small farmers to buy land, c) credit for agroindustries, d) subsidizing agricultural inputs, and e) minimum price policies for export products.

160. At the outset of the colonization effort, the government began a large-scale campaign on radio, television, and press to attract settlers from several parts of Brazil. Some announcements even mentioned that the majority of Amazonian soils were suitable for agriculture (despite evidence to the contrary). The treatment received by initial colonists was impressive and often included: transportation to the colonization site, a 100 ha. plot, a modest four room house, six months subsistence wage, technical assistance, low interest rates, subsidized production inputs, minimum price guarantees, basic infrastructure (school, health posts, feeder roads), and basic food supplies from government suppliers (Moran 1983; Smith 1982; Wood & Schmink 1978; Arruda 1976).

161. In order to serve colonists, INCRA developed a system of PICs (Projects of Integrated Colonization) located outside major towns along the Transamazon (Maraba, Itaituba, and Altamira. The PICs consisted of different levels of infrastructure and services at different intervals along the highway: the agrovila located at 10 km intervals, the agropolis every 20 km, finally the

³¹ Less than 1 percent of Brazil's landowners control almost half of the country's farmland.

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ruropolis, at 140 km intervals, with banks, airport, hospitals, and administrative centers.

162. Unfortunately, most of these projects were laid out with little attention to local conditions³². Altamira, the only project with substantial good soils was designated as the showcase project. Here too, the PIC scheme failed to emerge. Reasons for the program's failure include: a) bureaucratic operational problems of design and implementation, b) heavy credit emphasis on annual crops, c) poor service delivery and inappropriate technical assistance, d) poorly prepared colonists, e) low agricultural productivity, and f) lack of basic infrastructure (Moran 1975, 1981; Smith 1976, 1982; Wood and Schmink 1979; Bunker 1982). Of the 66 agrovilas planned west of Altamira, only 27 were ever established and most of these did not have the amenities promised to initial colonists. Only one ruropolis was ever built and only 3 of the 15 planned agropoli were completed³³.

163. By the mid 1970's, the government, faced with increased criticism from powerful lobby groups (notably the Association of Amazon Entrepreneurs or AEA) and an apparent loss of political will to continue the effort, declared the project a failure. Only 7,900 families of a projected 100,000 were settled in the five years of active government support for the project (Skillings & Tcheyan 1979). At this point, policy shifted away from this emphasis on landless farmers toward private colonization for small and medium sized land owners, on the one hand, and incentives to attract large investment capital to the region on the other.

164. Agricultural Settlement in Rondonia. While the government undertook the ambitious Transamazon settlement project in the early 1970's in eastern Amazonia, colonists were beginning to settle in Rondonia. Here the government made little effort to select colonists for pre-planned agricultural communities (as it had on the Transamazon), but simply tried to settle the agricultural colonists that flooded into the area starting in the early 1970's with the improvement of the Cuiaba-Porto Velho road (BR 364).

165. Beginning in 1970, INCRA followed the same PIC model used along the Transamazon in Rondonia. By 1975, 5 more PICs were formed as a result of the rapid overburdening of the two original planned PICs by spontaneous migrants to

³² The Maraba project, for example, was substantially curtailed due to a high incidence of malaria. The Itaituba project was cut back because it was located on patches of very poor soil.

³³ Financial figures for the PIC program are hard to come by. Nascimento (1985: 336) estimates that each agrovila cost the government around US\$ 425,000 and the cost per colonist was US\$ 13,000, excluding INCRA's administrative costs.

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Rondonia, growing at a rate of 16% annually.

166. INCRA's slow pace in land titling and uneven provision of services to new migrants have been identified as principal factors in congestion and confusion that characterized agricultural settlement in Rondonia by the late 1970's (Arruda 1976; Martine 1980; World Bank 1981). By mid-1977, close to 30,000 migrant families were waiting to be attended by INCRA. In the absence of action, many of them sought other solutions to their problems including: 1) invading Indian areas, un-allocated INCRA plots, and lands outside official colonization areas (reached through the extension of project feeder roads), 2) entering into sharecropping arrangements with others who had obtained land, and 3) joining the poor seeking work in the newly erected urban areas.

167. The POLONOROESTE Program. Land settlement in Rondonia was to be promoted through land distribution and a broad, integrated rural development program (POLONOROESTE) announced in 1981 the same year that Rondonia was granted statehood (see Map ?). The program included investments in infrastructure (roads, storage facilities, and extension service centers), health care, Indian and environmental protection³⁴, and agricultural extension. A central component of the POLONOROESTE program was to improve and pave the BR-364 which provided road access to southern markets. Between 1981 and 1986, this project cost almost 2.25 billion, a third of which was financed by the World Bank.

168. An important element in Rondonia's integrated rural development program was the construction and staffing of rural support service centers at strategic locations accessible to farmers. The impact of these centers was diminished for two reasons: 1) the poor feeder roads did not provide a reliable transportation network within the project, keeping extension agents from providing reliable services to farmers, 2) constant shortages of project funds for gasoline meant that extension agents could not count on getting to the farmers even when roads were passable. The nature of agricultural extension services further aggravated the ability of small farmers to adapt to the new environment. Extensions services continued to promote technical packages (improved seed and chemical inputs) that most poorer farmers could not afford. In addition, the poorest farmers lived on the most isolated plots, areas that were rarely visited by the agents. Consequently, more capitalized farmers with less isolated farms were the primary beneficiaries of extension efforts.

169. By 1985, migrants were entering Rondonia at a rate of over 200,000 individuals (approximately 50,000 families) per year. Government plans in 1985 proposed new settlements (by 1988) for less than half of the families that entered the state in 1985. Because there were no official efforts to dissuade landless farmers from migrating to Rondonia, orderly implementation of new

34. The environmental protection included in the initial POLONOROESTE project involved a promise by INCRA's to put the 50% of agricultural plots that are, under Brazilian law to be set aside as conservation areas, into contiguous blocks rather than individual plots. This was intended to facilitate monitoring and collective management that could generate income for colonists (Nascimento 1985).

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settlement projects were constantly under threat of spontaneous invasions by landless migrants.

170. At the same time, government policies supported the acquisition of large landholding by private investors. In the municipality of Ariquemes, for example, nearly as much land was sold by the government at nominal cost to a handful of wealthier individuals as was distributed to all of the farmers in the Marechal project. Wilson (1985) states that most of these holdings were not in productive use, hence they were not even generating labor opportunities for the growing number of landless poor in Rondonia. As it became clear that the better lands had already been occupied and that paving of the BR-364 would continue to Acre's capital, Rio Branco, settlers who had failed to acquire land in Rondonia started to move into Acre (Fearnside 1984; Furley 1980).³⁵

There is very little information in the general literature on the actual costs of settlement projects. Tavares (1972) cites a number of factors that make it difficult to obtain the necessary data to determine an average settlement cost per family, including the long term of most projects and the variation in the number of beneficiaries and services provided. Tavares uses figures from 10 projects in Brazil to derive an average settlement cost of US\$ 2,547 (1971 dollars) per family. This figure included the cost of road construction, basic service infrastructure (schools and hospitals), electricity, and extension agents and technical personnel. According to Tavares, at this cost, families settled could easily afford to pay for these services with an 8% interest rate spread over a 15 year period (page 114). Tavares (1972) provides additional figures on the cost of four irrigated agricultural settlement projects (2 in Brazil) and reports an average per family cost of between US\$ 12,000 and US\$ 20,000. Obviously the number of services provided will increase the overall cost of the project.

171. Private Colonization. Private colonization was not a new concept and had been tried with mixed success in southern Brazil (Foweraker 1981; Nelson 1973; Tavares 1972; Dozier 1969). By the mid 1970's public colonization along the Transamazon highway had become a disappointment for policy makers, some of whom had viewed private colonization principally as a strategy for agricultural occupation in strategic areas of the Brazilian Amazon. Consequently, by the late 1970's, the Government's strategy shifted in the direction of creating incentives to attract large capital to the Amazon. For this reason, as well as a desire to remove itself from the problems associated with the Transamazon initiative, governments encouraged private firms to acquire lands at very cheap prices for subsequent resale to colonists.

172. Private colonization was a key feature of Programa de Polos Agropecuarios e Agrominerais da Amazonia (POLOAMAZONIA), established during the Geisel Administration. Private colonization was also provided for in the Estatuto da Terra (Land Law) and as Arruda (1976) points out, there were already some private colonization projects in Amazonia when POLOAMAZONIA was announced.

³⁵. For additional information on the occupation of the Rondonia frontier see Almeida 1984 and Alencar 1987.

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POLOAMAZONIA explicitly sped up the pace of land distribution and increased the size of holdings: instead of the previous cap of 3,000 ha. without Senate approval, private companies could now obtain up to 66,000 ha. of land for cattle and forestry projects and 500,000 ha. for colonization projects (Nascimento 1985; Arruda 1976; Foweraker 1981).

173. By the late 1970's, numerous developers from southern Brazil became interested in colonization as a business proposition³⁶. Later on, the Greater Carajas Program, established in 1980, included some support for agriculture colonization projects in eastern Amazonia. Unfortunately, many of the proposed private projects failed to accomplish their stated objectives as a result of a variety of social, economic, administrative, and environmental factors.

Between 1968 and 1984 INCRA approved 71 private settlement projects: 66 in Mato Grosso, 3 in Para, and 2 in Maranhao. Huge tracts of land were acquired (from 400,000 to one million hectares), primarily for the settlement of colonists from Brazil's agricultural south, sometimes in collaboration with large cooperatives (in the south) who were eager to find alternatives for their members as they sold their land locally. Beginning in 1973 with the 400,000-hectare SINOP project in Mato Grosso, economic performance has been mixed. Some projects, located on relatively poor soils, faced problems of soil exhaustion, others, like Tucuma, suffered from the collapse of government support programs and the subsequent invasion by landless farmers. Some projects, Aripuna and Colider in Mato Grosso, were accused of invading Indian lands (Branford and Glock 1985). Others, like the Alta Floresta project, were relatively successful in developing crop production and agribusiness activities.

174. Although occupying extensive areas of land, private colonization never came near to settling the number of colonists that public projects did. As Skillings and Tcheyan (1979) point out, private efforts settled less than 10% of the number of families settled by government projects. In 1980 private efforts settled 10,000 colonists. By 1982, this number had fallen to 2,491, primarily as a result of changes in credit policy limiting the amount of resources lent for land acquisition and for infrastructure (Nascimento 1985). According to Pompermayer (1979) prior to 1982 the Bank of Brazil's PROTERRA program financed 80% of the land on sight and the colonist paid 20%. This way the company got almost 100% of its sale up front.

³⁶ Nascimento (1985) states that by 1977 twenty companies had registered 32 colonization projects (the majority located in northern Mato Grosso including Alta Floresta, Sinop, Cotia, Juruena, Cotrijui). Together these projects covered close to two million hectares of land (Branford and Glock 1985). Colonization as a business put firms in a position to exploit colonization project natural resources in a variety of ways including: 1) selling land, 2) extracting natural resources, and 3) control over the buying, refining, and marketing of agricultural products. Although most firms participated in several of these ventures, land sales represented the initial attraction (Butler 1985).

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175. Regardless of the degree of project success, the infrastructure created during the initial project phase of public and private efforts alike served as a magnet for a variety of occupational groups, including landless farmers, miners, and lumbermen eager for better access to the region's natural resources. In this sense, their role as a catalyst for the occupation and exploitation of the region has far exceeded their ability to establish productive, sustainable agricultural settlements.

176. The National Plan for Agrarian Reform. The National Plan for Agrarian Reform (PNRA), announced in October of 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 Amazonia between 1985 and 1989. Unfortunately, the effort suffered a number of revisions that weakened its original scope as regional land reform plans were discussed and finally approved by the federal government in May of 1986. Of the 10 million ha. 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 original national target) had been resettled and, of that number only 836 families were in Amazonia. 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 ranchers³⁷.

177. 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 (Para, Amazonas, Roraima, Acre, Rondonia, Amapa) the most contentious region of Brazil with 141 registered land conflicts and 48 deaths since last year (Comisao Pastoral da Terra 3/89 figures)³⁸.

³⁷ A major victory from the landowners' perspective was the Decree-Law (No. 2,363) 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 ha. 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.

³⁸ 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 use rights in the advance of extensive cattle ranching operations.

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Agricultural Production in Amazonia

178. All agricultural settlers in the Amazon confront a number of similar problems as they adjust to the new physical, social, and economic environment. These 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 agricultural production and the establishment of productive agricultural settlements in Amazonia.

179. The 1985 census data (IBGE) reports that only about 20% (98 million ha.) of the region is occupied for agricultural purposes. Less than 20% of this occupied area is planted (17 million ha. including annuals, perennials, artificial pasture, and reforestation). Approximately 30% of this occupied area is in unimproved or natural pastures.

180. Food Crop Production. Many small farmers in the Amazon practice what has been described as the "peasant pioneer cycle": a) clearing and burning the forest, b) planting food crops for 2 to 3 years until natural soil fertility declines, c) converting to pasture, and d) selling or abandoning the plot. It can be argued that the move to pasture formation is accelerated by the relative failure of stable crop production.

181. Annual food crops (rice, corn, beans, manioc) are planted primarily by small farmers. Of the 17 million hectares of land cultivated in 1985, almost 65% was in these basic food crops. Critics of annual crops (viz proponents of perennial) 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.

182. Perennial Cash Crop Production. Over the last decade, government extension agents have actively promoted perennial crops as the best agricultural alternative for the region. From the standpoint of the extension agents, these crops offer numerous advantages over annual crops. In general, they are 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.

183. Unfortunately, the economic future of perennial crops production is much less optimistic than its agronomic potential, largely due to an international surplus of production of coffee, cocoa, and natural rubber. As a consequence of the resulting low prices, as of 1987, perennial crops (including coffee, rubber, bananas, cacao, oil palm, and black pepper) accounted for only a small fraction (452,100 hectares) of the 17 million hectares under cultivation (1985 Census).

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184. From the small farmer's perspective, annual crops are preferred over perennial for the following reasons:

- 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.

185. Perennial, 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.

186. Credit and technical services for these 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 necessary to bring about 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 Rondonia felt that they could simply not afford the recommended technical packages given the price of the product.

187. Marketing of Food Crops. Although little hard data are available on the ultimate destination food crops produced in frontier Amazonia, evidence suggests that a substantial portion is 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).

188. During the early years of frontier settlement, demands for staples (rice, corn, beans) are often met in part by food trucked in from states outside of 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.

189. Often the condition of principal highways leading into the region are better than the roads locally. 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).

190. Grain storage systems also tend to be inadequate to meet farmer's needs. The combination of inadequate storage services and lack of a reliable means to get crops off the farm and to the market on a regular basis have resulted in significant losses for farmers.

191. Marketing Perennial Crops. Different perennial crops are marketed in

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

192. In Amazonia 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 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 Amazonia (Wilson 1985; Moran 1975; Tavares 1972).

193. Market problems are fundamental for perennial crops, horticultural crops and grains. Virtually any of these crops can be grown in the south under conditions guaranteeing higher quality and much lower transport costs.

194. Sustainable Agricultural Systems. Although it is risky to generalize about the Amazon as a whole, it is generally true that once the nutrient-rich biomass is removed, the underlying soil itself is acidic and relatively infertile oxisols and ultisols (see Cochrane and Sanchez 1982). This is especially true of the upland or terra firme areas which account for about 70% of Amazonia.

195. Among the most sustainable agricultural systems in Amazonia are those employed by the Indian and Caboclo (Amazonian peasant) communities which involve a low-population-density shifting cultivation where soil nutrients are replaced by a fallow cycle (often 1 years) that includes rotation and burning of vegetation (which yields a nutrient-rich ash). The size of areas cleared and burned are considerably smaller and fallow time considerably longer than those employed by colonist and migrant farmers. Since traditional forest communities generally have a long-term interest in the area, efforts are made to manage trees of recognized economic value. Other species of economic value are also introduced into the area for future use. Finally, resource use is quite diversified with differing degrees of hunting, fishing, gathering, and cultivating. Unless severe resource depletion occurs, or the human population expands relative to its resource base, a reasonable subsistence can be derived by these groups.³⁹

196. A growing body of applied research suggests that Amazonia will only achieve its agricultural potential through the adoption of farming systems compatible with the rainforest environment. Of special interest are the fertile

³⁹. The systems employed by forest dwellers are often described as agroforestry since they combine horticultural activities in the understory with the management of various tree crops. For further information on these sustainable systems see Moran 1981; Fearnside 1985a; Posey 1985; Collins 1986a, 1986c, 1987; Clay 1988; Denevan 1981.

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varzea or floodplain areas which comprise about 2% of Amazonia yet offer the potential (with proper flood control) of producing paddy rice, tree crops, food crops, jute, water buffalo, and managed fish production (Barrow 1985; Brienza, et. al. 1983; Alvim 1972 and 1981; Falesi 1974).

197. Researchers are also looking at new forms of crop production in upland areas (terra firme) based on traditional systems (described above) but adapted for areas of higher population density (Nicholaides 1983; Alvim 1981; Fearnside 1983, 1986b). Cattle raising may also have its place with careful grazing management and smaller systems that can be rotated over longer periods of time (Alvim 1981; Falesi 1974; Nepstad, personal communication).

Government Programs and Policies

The principal mechanisms through which government has supported small farmers has been through credit, extension, marketing and price support services, and fiscal incentives. These are reviewed briefly below.

198. Credit and Extension of Technical Services. Credit programs to support the cultivation of rice, corn, and beans have done little to promote these crops. Many small farmers are wary of this type of credit because of the risks associated with crop production. In addition, the delivery of credit has been criticized for: a) 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 b) 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 shown a tendency to use credit for other (nonagricultural) purposes which they see as better investments.

199. 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.

200. 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. In many parts of the Amazon today, these agencies are practically non-existent. This is partially due to a severe funding crisis that has left many extension offices with reduced personnel and operational budgets. Another problem is that extension agents have not always put emphasis on those areas that are most important to newly arrived settlers. Since feasibility studies are rarely done, accurate information on soils and rainfall patterns are often not available to help settlers make important decisions. More than one project has been affected by lack of attention to location of the best soils. Agencies promoting specific cash crops such as CEPLAC (the government cacao agency) seem to provide somewhat better services.

201. Since 1987, with a devolution of budgetary responsibilities to the states extension services in the Amazon have been in a severe decline. Nearly 70% of the budget for extension services (EMATERS) in the Amazon is absorbed by salaries. Farmers have by and large ignored extension service advise with

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respect to input packages. Whether principally due to inappropriateness of the packages, lack of credit or ignorance is not clear.

202. The most likely explanation for lack of adoption of suggested technical packages is that they are inappropriate for the physical and economic environment. For example, according to a survey of colonists in the Machado settlement in Rondonia (Miranda 1987) there was insignificant use of soil analysis, liming and fertilizing in the project, despite the existence of an EMBRAPA research station in the project (which 35% of the settlers were aware of and 11% had visited. (There was limited use of graded seeds and soil conservation practices, however (12-15% of the farmers), depending on the crop.) In view of the stage of production of the project this is not be surprising, however: 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.

203. An additional problem with the state extension services is the tendency of extension agents to view frontier areas as "hardship posts" which they leave as soon as other alternatives become available. Extension agents are also reported to be often poorly informed concerning local resources and appropriate technology and to be poorly integrated into the community.

204. Marketing, Price Support and Transportation Subsidies. A critical limitation to growth of food crop production in Amazonian settlements is the lack of local markets. Efforts to penetrate markets to the south, on the other hand, compete with lower transport and storage costs. In addition recent increases in food crop production in the rest of the country have increasingly marginalized the more remote initiative in the Amazon. These increases are primarily from areas closer to the major markets (Belem-Brasilia, Mato Grosso, Matto Grosso do Sul, and in the internal frontiers of the traditional producer states), as well as recent advances in irrigation along the river valleys in the Northeast

205. With this lowering of real retail prices due to national abundance, the penalty imposed by distance looms increasingly important. In addition real freight costs increased by 50% in 1989. Estimates in Rondonia (Lopes, 1990) suggest that in 1989 freight costs for maize (to the nearest major market) as a percent of wholesale price were 20%, 16%, and 44% for Goias, Parana, and Rondonia, 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 Goias and Rondonia, respectively.

206. This tremendous locational disadvantage has been neutralized historically in certain areas of high priority by the CFP's purchases under the minimum price

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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 PDRI's of Mato Grosso and Rondonia. In effect the cost of locational disadvantage was passed to the taxpayer.

207. The fragility of this system became evident in 1989 however, when due to lack of resources, CFP scaled back dramatically its participation. In the PDRI of Rondonia, CFP reduced purchases of rice, beans and maize was slashed from a total of 107 thousand tons in 1988 to 18 thousand tons in 1989. CFP cutbacks in the PDRI of MATO Grosso were slashed from 400 thousand tons to 30 thousand tons.

208. As a result of this lack of activity of CFP rice and maize found virtually no market in Rondonia in 1989. Because of its much lower transport costs relative to market value, on the other hand, beans found a good market to the south even in the absence of government intervention.

209. An additional wedge between economic viability and private profitability is the uniform price system for fuels. According to IPEA (reference), the elimination of this subsidy would lead to a weighted average increase in the price of diesel fuel of approximately 35% in Rondonia, and nearly 50% in northern Mato Grosso. This would lead to an increase in the cost rice and maize production by 5% in Rondonia and between 6% and 7% in the North of Mato Grosso (Rondonopolis), with similar increases in the costs of freight.

210. Fiscal Incentives. Government programs have consistently favored large-scale agricultural schemes over support for farmers. The agricultural projects approved (by 1985) as part of the Greater Carajas Program (PGC) included oil palm processing, forestry and ranching projects, and a sugarcane ethanol distillery, with virtually nothing for the development of social infrastructure (co-ops, etc) and small agricultural enterprises. This disproportionate situation was further exacerbated by SUDAM's tendency to give preference to the same type of project through FINAM (Investment Fund for Amazonia).

211. Local farmers are also affected in various ways by other economic activities, promoted by the government. In the Carajas area, for example, the pig-iron smelting projects located along the Carajas railroad near Maraba (in Para) and Acailandia (in Maranhao) have had a significant impact on local farmers. Although long-range plans intend to utilize eucalyptus plantations for most of the estimated 25 million tons of charcoal required annually for smelting. However, short-term needs for charcoal will be supplied by the local population (including many small farmers) exploiting native stands. This would result in felling of approximately 1,000 square kilometers of forest annually (Hall 1987). Other links between farmers and other economic activities are discussed in subsequent sections (see Loggers, Mining, etc).

Discussion and Recommendations

212. Improved Land Tenure Relationships. Poor farmers who have failed to gain access to farm land in Amazonia remain a major problem today. The difficulty in

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obtaining title to squatter's land is certainly one part of the problem. More efficient titling would be one step promoting more stable farming communities throughout Amazonia since title is often a prerequisite to obtaining credit and other services. Titling should be delinked from any requirement related to "productive use", however. Such "anti-speculation" legislation is generally unsuccessful at creating economic opportunity where it did not exist previously. Its major effect is to force "premature" (uneconomic) activity as a cost of establishing title⁴⁰.

213. Technical Packages. Any technical package intended to stabilize Amazonian agriculture must have two characteristics. First, it must not rely on government subsidies. Such subsidies are inherently unreliable, and put Northern Agricultural in an untenable position of relying on sustained fiscal transfers from the South. Second, an acceptable package must be capable of providing a farmer using biologically sustainable techniques a better standard of living than he can gain through the "peasant pioneer cycle". As long as nutrient mining is more profitable than settled agriculture, it will continue to be the prevailing practice.

214. 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 alternatives⁴¹. 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), however labor costs were excessive and careful attention to nutrient deficiencies would still be necessary.

⁴⁰ Anderson (1989) refers to "premature economic activity" under similar circumstances in the settling of the American west.

⁴¹ 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.

**Annex IV
Garimpeiros and the Placer Mining Sector**

215. The informal mining sector plays an important role in the economies of the Amazon. Placer mines are scattered throughout the Amazon. They exploit metals that are easily mined and not dependent on large and sophisticated mining operations. Gold is the most significant of these, with cassiterite (tin ore) playing a secondary role.

216. Since the start of the Brazilian Amazon gold rush in 1980, garimpo, or placer mining, has played an increasingly important role in regional mining. Although placer mining existed in areas such as the Tapajos basin (western Para) as early as the 1950s, rising gold prices, a worsening economy, an influx of migrants, and the discovery of very dense concentration of gold in vein in Serra Pelada (southern Para) all contributed to the gold rush that began in 1980. By 1982, over 50,000 garimpeiros were mining in the Serra Pelada and Cumaru mines in the Carajas area of southern Para (Schmink 1985).

217. Table 3 compares garimpo with industrial production (carried out by

Table 3

**GOLD PRODUCTION FOR THE BRAZILIAN AMAZON, 1980-88
(In tons)**

	Producer/a	Official	Real/b	Total
Para	G	145.1	570	715.1
Mato Grosso	G	38.4	180	222.5
	I	4.1		
Rondonia	G	18.3	75	93.3
Amapa	G	2.9	18	26.4
	I	5.5		
Roraima	G	8.7	40	48.7
Maranhao	G	1.5	6	7.5
Others	G	2.0	10	12.0

a/G = garimpo production; I = Mining company production

b/Estimated unreported production

registered mining companies) of gold. The table also provides figures for both the official and real production of gold over most of the last decade (1980-1988). Real production figures represent official production (that which is reported to the government) plus the amount that is estimated to be sold

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illegally. The DNPM (Departamento Nacional de Producao Mineral) estimates that real gold production is between 3 and 5 times official figures. Between 1980 and 1988, the Legal Amazon produced (by official estimates) \$13 billion in gold. This represents over 80% of the Brazilian national gold production for that period. Garimpos were responsible for the majority of this production.

218. The DNPM estimates that garimpos cover about 170,000 Km² (roughly 4%) of the approximately 5 million km² Legal Amazon. Within the Legal Amazon, Para State has the largest area dedicated to garimpo activity, approximately 100,000 km² (according to the DNPM). Table 3 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 of high incidence of malaria.

219. Estimates of the number of people directly involved in garimpo activity vary between 650,000 (DNPM) and 800,000 (DNEHSA) for legal Amazon. These numbers include those individuals who provide general services to the garimpo (from transportation to sales of basic goods, and entertainment). The number of actual miners is probably between 300,000 and 400,000 individuals at any one time, with many part-time miners rotating in and out of the garimpo.

220. 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: 1) in Para the Tapajos River basin (400,000) and Serra Pelada/Cumarú complex (130,000); 2) in Mato Grosso, the municipalities of Alta Floresta and Peixoto de Azevedo (170,000); 3) Rondonia, in particular, the Madeira River (60,000). These areas, along with the almost 100,000 miners in Roraima, represent the major placer mining complexes in Amazonia.

221. The mining camps themselves typically contain anywhere from several hundred to several thousand miners each, except in cases of 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 garimpos in operation in Para, most associated with the two large complexes of Tapajos and Cumarú/Serra Pelada.

Access to Garimpos

222. Placer mining areas can be differentiated according to several inter-related variables including ease of access, relative level of technology, capital investment, type of gold deposit, and proximity to other economic activities and population centers. Although these distinctions do not yield a neat typology, they help explain both the relative influence of the garimpo locally and the difficulty government agencies have faced in the regulation of various garimpo activities.

223. Unlike many other economic activities in the region, gold mining (because of its very high value/unit weight and volume) does not depend on roads. If miners traveling on a river or through trails in the jungle happen upon a rich

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deposit, an area is then cleared for an airstrip (Pista) and soon supplies and more miners are flown in from the nearest town with an airport. Many garimpos can be reached only via such small airstrips, or pistas.

224. The Tapajos gold mining area in western Para is a classic example of a complex dominated by "pista mines." It is located south of Itaituba between the Tapajos river and BR-163 (the Cuiaba-Santarem). It is arguably the country's largest garimpo, covering 60,000 km². and has been the site of gold mining activity since 1958. The approximately 400,000 individuals currently involved in garimpo activities in the Tapajos are served by a fleet of over 200 planes, working primarily out of Itaituba, a town of close to 20,000 inhabitants and over 200 official gold buyers.

225. Brazil's newest gold rush boom area, the State of Roraima, is also an example of pista-based mining. With over 300 takeoffs a day, the Boa Vista airport is one of the busiest in Brazil.

226. Road access definitely aids in the expansion of mining since more people with less means can reach the area. Heavier equipment can also be brought in with greater ease. Road access also means that it is more difficult for anyone attempting to control the mine to keep competitors or any group of people deemed undesirable out of the area. There are cases where the government or the mine's main financier or merchant (sometimes called the "dono de pista") have attempted to control the flow of miners into the area through control of the airstrip. In the case of the government-controlled Cumaru mining complex, for example, there was an attempt to keep women, alcohol, and firearms out.

227. If the gold fields prove rich enough and an existing road is not too far away, then a road may eventually be built. In the mid 1980s the government constructed an extension to the Cuiaba-Santarem highway (called the Transgarimpeiro) to provide some highway access to the Tapajos garimpo area.

228. Southern Para, which includes such mining areas as Serra Pelada, Cumaru, and Tucuma, is another area where roads, initially constructed for agricultural settlement, have aided the proliferation of garimpos. Rondonia's major mining area, along the Madeira River, is also easily assessible from Porto Velho, the State's capital.

Placer Mining (garimpo) Technology

229. Garimpo technology is very varied and depends on the accessibility and age (richness) of the site. It runs the gamut from manual panning and rustic wooden sluice boxes to relatively sophisticated 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 rapidly excavate gravel and dirt. Small motorized crushers are used to pulverize rock. In a final step, gold bearing sediment is washed allowing heavier gold to settle in various steps in a slide-like trough while lighter sediment washes past.

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230. In most areas, alluvial gold dust is excavated near small stream beds. The major exception to this is the dredging of major rivers, like the Madeira (Rondonia), where underwater divers use hoses to comb the streambeds. The operations on the Madeira operate from as many as 6,000 large motorized rafts and represent a significantly higher investment of capital than the more standard operations described above.

231. 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).

232. 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 that used to be the world's largest placer mine. Over its 10 year history, Serra Pelada produced about 40 tons of gold, 14 tons of which were produced in 1983 alone. With current garimpeiro technology, Serra Pelada was barely able to produce 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 possibly initiate new excavations that may yield as much as 10 to 30 tons of gold (Pinto, 1990).

Linkages to Local Economy

233. Although undoubtedly of importance in certain cases, such as Rondonia, there is very little good information on the effect of garimpo activity on the local economy. Despite this lack of hard data, the following statements can be advanced as to the possible impacts of an economy which involves 800,000 individuals and produced over \$13 billion in revenues in less than a decade.

234. Regional Service Centers. Within the region, the greatest impact will be felt in those areas with the heaviest garimpo activity. These areas include: 1) northern Mato Grosso, 2) south-central Para, 3) western Para along the Tapajos, 4) Rondonia along the Madeira, 5) northern Amapa, and 6) northwestern Roraima.

235. 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 continue to 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 allow them to provide services to other economic activities that may be evolving (lumber, agriculture, ranching).

236. In Porto Velho, Rondonia local construction industry has experienced a

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boom with the construction of the hundreds of rafts involved in mining activities on the Maderia River. In southern Para, the population of Maraba is estimated to have increased from 60,000 in 1980 to 133,000 in 1985 and some 250,000 today. Maraba, in Para, is an area that has been influenced both by Carajas and Serra Pelada (see Map 1 for proximity of garimpos to urban centers).

237. In general, the better infrastructural access and the greater the proximity between garimpos and 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, into the overnight investment, and into contraband items.

238. Garimpeiros, Region of Origin, Profits. Although lacking firm quantitative data, the following assertions about garimpeiros appear repeatedly in the literature:

- a. A majority of garimpeiros probably do not come from the Amazon region. In many cases they come from the northeast and from states bordering the Amazon such as Maranhao, Tocantins, and Goias. Many return home periodically to help support families or make small investments in their region of origin. Unless they are merchants, few miners will probably choose to invest their meager savings locally.
- b. Most garimpeiros are young men in their twenties and thirties. Many come from the ranks of landless peasant farmers and unskilled rural and urban workers. Many will leave the garimpo little better off than when they arrived. Most miners get a small percent the total gold extracted, varying from 3% to 8% depending on their tasks. More and more miners now receive a daily wage.
- c. The cost of living in a garimpo is very high, with some items from 50% to 200% more expensive than in Southern Brazil. Medical expenses, especially malaria treatment, can quickly eliminate any small savings. Nevertheless, the garimpo offers these individuals a degree of hope and freedom often not possible in their other occupations. Miners may come and go as they please. The garimpo also keeps alive the possibility that any miner can strike it rich. Many who do make some money, spend it just as quickly enjoying for a brief time the illusion of wealth.
- d. The few that are able to accumulate enough money to invest in mining machinery and become petty "donos" (owners) are still very dependent on credit extended by suppliers of food and fuel. Merchants, plane owners, pilots, and others who have invested in the garimpo usually do not choose to live there choosing instead municipal seats and state capitals (Cleary 1987).
- e. Many garimpeiros are part-time miners. Garimpo activity is important to the short-term survival of many Amazon migrants who have failed to make a living solely from other activities, including agriculture. Schmink (1985) found that among garimpeiros in southern Para and Mato Grosso there

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were many fewer full-time miners than part-time miners who were also small farmers and rural workers. The attraction of the garimpo for these individuals is the opportunity to earn money at a quicker rate than they could working elsewhere. Poverty and underemployment help drive people to the garimpo in order to survive (see Cleary 1987).

239. In sum, most of the money spent in the garimpo itself goes toward the maintenance of the miners and the mining equipment. There is very little incentive to invest locally since 1) there is little to invest in outside of mining, 2) most miners come from other regions and will choose to spend their money there, 3) many miners will leave the mine relatively poor, with little money to invest in anything.

240. One segment of the national economy that is certainly benefiting from the mining boom are manufacturers and retailers of the machinery used in the garimpo, much of which is produced in Brazil's industrial south.

241. Direct and Indirect Effects on Agriculture. The garimpo's effect on agriculture in Amazonia is mixed, depending largely on the relative effect on input and output prices. Overall, farmers located near the regional service centers described above will prosper as these areas themselves prosper, largely because the effect on output prices will more than compensate the effect on inputs. Farmers located near a garimpo area but not near one of the regional service centers, on the other hand, suffer from the negative aspects of the garimpo (high costs of labor, malaria) as well as lack of access to banks and other services.

242. 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 at the same time severely disrupt the establishment of other economic activities.

243. Thus the timing of a gold strike may be crucial in determining the degree to which other activities will be affected positively or negatively by mining activity. If farming and ranching have become established to some degree prior to the discovery of gold, or if transportation infrastructure exists, the gold strike may provide a basis for local investment. If, on the other hand, farming or ranching reach the area along with the gold rush, competition for wage labor is likely to create severe constraints to growth.

244. To survive and even prosper as a result of a local gold rush depends to a certain degree on the individual farmer's economic situation, viz, his access to family (or otherwise reliable labor), his ability to diversify, his willingness to invest in his operation, and the quality of land.

245. Often the individual farmer's situation may improve in the short run but at the expense of his farming operation. A very poor farmer may decide to become a garimpeiro. A farmer that has gold discovered on his land may decide

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that he can sell out to some of the mine owners or negotiate a royalty of some sort and abandon farming. Other farmers on the other hand, may use their truck and equipment to work for local miners and use the earnings to invest in their farming operations.

246. The effect of garimpagem on output markets generally does not 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 to garimpos, it seems clear that many garimpo areas, especially those that exist at great distances 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 transport is a premium. Garimpeiros may also hunt and fish to supplement their diet.

Direct Impacts of the Garimpo on Native Populations, the Environment, and Health

247. Environmental problems resulting from garimpagem include those associated with changing of stream courses, deforestation, siltation, and the pollution of rivers with metallic mercury, motor oil, and human waste. In addition, garimpo areas are sites of malaria, sexually transmitted diseases, hepatitis, and a variety of human ailments associated with uncontrolled boom towns.

248. For example, the Tapajos river, whose natural color is green, has now turned yellow as a result of suspended materials. This, in turn, cuts down on the sunlight needed for organic life in the rivers. Large amounts of soil needed to move and wash the pay dirt are emptied into the river. Detergents, used by miners to clean oil from the water which reduces the amalgamating action of the mercury on gold, as well as oil are also observed far down stream.

249. 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.

250. Malaria and other General Health Problems of the Garimpo. 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 of the mining area. 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 a scarcity of basic health services.

251. Garimpos facilitate the transmission of malaria for the following reasons: 1) close living quarters, usually with no walls or screens to reduce feeding mosquitos, 2) the forest clearings with many poorly drained areas provide ample breeding ground for mosquitoes, 3) garimpeiros serve as carriers of malaria, both from one camp to another and to areas beyond the garimpo, 4) common self-medication with anti-malarial drugs contributes to greater parasite-drug resistance, 5) difficult access of many garimpos makes sustained DDT spraying by

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SUCAM (the federal agency charged with malaria control) almost impossible.

252. 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 Para, 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 Amapa in 1986 came from just two garimpo areas. Finally, in Rondonia, 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 came from garimpos in Sao Felix do Xingu municipality in southern Para 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).

253. Mercury Contamination and the Garimpo. Despite the known health problems associated with mercury contamination, its use is pervasive. This is so principally because that of the means available to capture gold at different stages in the mining process, metallic mercury is currently viewed by most garimpeiros as the most efficient way to concentrate alluvial gold dust. The finer the dust, the more mercury is used. Thus in reworking "tailings" mercury is even used to line the sluice box. According to DNPM estimates, for each gram of gold extracted there are two grams of mercury used. Rogerio da Silva, former environment coordinator for DNPM (Belem) calculates that over 330 tons of mercury have been used in the Tapajos 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.

254. There are at least three groups at risk of 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.

255. In 1989, the DNPM collected 700 samples (550 in Para, especially the Tapajos) of hair, blood, sediment, water, and fish from garimpo areas throughout the Amazon, with all indicating some evidence of mercury contamination (da Silva 1989). Other studies carried out by CVRD contractors investigated garimpeiro sites within the greater Carajas 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.

256. Ellen Silbergeld, a toxicologist with the University of Maryland's School of Medicine who has become interested in mercury poisoning in Amazonia, reports that many gaps exist in assessing the situation from the public health perspective. Much of the work to date has involved environmental monitoring including the sampling of fish, water, and sediments. According to Dr.

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Silbergeld, much of the monitoring has not been systematic. In the studies cited above much of the fish sampling, for example, was done on material purchased at markets with no specific information on the location where the fish was caught.

257. Although sampling of human blood, urine, and hair has been done, the conditions of sampling are quite variable. Based on her interviews with researchers in Brazil, Dr. Silbergeld concludes that appropriate scientific procedures were not followed in past tests of human mercury concentrations. Dr. Silbergeld is currently analyzing 50 cases of mercury contamination collected by a physician in Santarem, however, along with information from a veterinary pathologist, which document spastic calves, deformed pig fetuses, and even some children with Minamata type signs.

258. Although in general one would expect the "demonstration effect" of the dangers of mercury usage to lead to the development of alternative techniques, several factors in garimpo areas seem to be at work to reduce its effect:

- a. garimpos are generally composed of relatively healthy young men;
- b. very sick individuals leave the area to seek help elsewhere, so there is a "self-selection" of only relatively healthy individuals;
- c. malaria is sufficiently common that symptoms from other ailments are often attributed to malaria. This might include the tremors resulting from mercury poisoning.

259. 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.

260. 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. The most dramatic incursions in Roraima have occurred 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.

261. 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).

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262. 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 Forest⁴². 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).

263. Some Indian groups, like the Kayapo in Para, 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 indemnization is paid to the property owner equal to 10% of the gold extracted.

264. In Para, there are approximately 2,000 Kayapo divided in 5 villages and occupying an area of approximately 32,000 square kilometers. 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 550,000⁴³ during the month of October, 1989. Although many Kayapo 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 (widespread malaria, for example) that were caused by the garimpeiros in the first place.

265. In the Tapajos region, the Mundurucu 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 the richer deposits in the area are not located in that area.

266. 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, however, without clear government support for Indian actions to deal with

⁴² 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).

⁴³ [BOB: HAVE JIM PROVIDE A \$ AMOUNT HERE AT AN AVERAGE EXCHANGE RATE FOR 10/89]

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garimpeiros, uncontrolled mining will continue to levy a heavy toll on native peoples.

Government Mining Policy and the Garimpo

267. Brazil's Second Mining Code (established in 1967) clearly provides state support for the formal mining sector by specifically outlawing unlicensed mining (garimpagem). Under these terms, garimpeiros were expected to leave any site for which a company had been granted production rights. The DNPM, with the help of the Federal Police, was empowered to close down illegal mining for any reason it saw fit. In the late 1960s, for example, the government closed several cassiterite garimpos in Rondonia, expelling 45,000 miners (Schmink 1985; Wilson 1985).

268. Large mining firms and the government justified the removal of garimpeiros because 1) their limited technology was wasteful while mining companies were able to remove more gold over a longer period because of their more sophisticated equipment and 2) the garimpeiros functioned as illegal mining companies since they did not pay taxes.

269. Garimpeiro organizations countered that they discovered deposits that the big companies did not know about. Once discovered, the big companies wanted the government to move the miners out. The miners also argued that the garimpo provided employment for a much larger segment of Brazilian society than the formal mining sector did. The law prohibiting garimpo activity in areas where companies held licenses was eventually modified to permit garimpos in areas with the permission of the mining company, which often retained the exclusive buying rights for the minerals mined (Schmink 1985).

270. The economic reality of the government's own fiscal problems and the gold rush of the early 1980s forced the government into tacit acceptance of the garimpo. By mid 1980, at least 30,000 miners had come to Serra Pelada, which at that time was producing about 26 kilograms of gold per day. Concern over security issues, the unregulated sale of gold, and the loss of potential revenues prompted the government to take over the administration of two of the largest mines in southern Para: Serra Pelada and Cumaru. The government also sought to regulate the sale of gold throughout the region, including mobile gold-buying teams in helicopters. Competition with other gold buyers also resulted in government buyers sometimes paying prices higher than the going market rate (Cleary 1978).

271. Over the last decade, the garimpeiros have formed organizations and learned to organize themselves better against threats to their livelihood. In 1982 the goldminers of Serra Pelada financed the successful campaign for federal representative (deputado federal) of the army officer who had helped run Serra Pelada and keep the area open for garimpo mining. By the end of the 1980s, the garimpeiros appeared to have largely won their battle with the mining companies for primacy in new gold mining areas.

Current Policy Issues

Garimpeiros

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272. Since the beginning of the gold rush in 1980, various government agencies have expressed interested in controlling garimpo activity for a variety of different reasons. These include: a) a desire to limit environmental damage and mercury contamination, b) a desire to improve the health conditions of the garimpo and control the spread of malaria, and c) a desire to control the sale of gold and capture some revenue through taxes.

273. Government efforts to deal with garimpo activity have generally failed because of a lack of 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 it difficult to implement even a clear plan of action.

274. 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 garimpo control. For example, the government has made little attempt to regulate the use of illegal landing strips and the planes that use them. In Roraima, there are only 3 registered air strips yet 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 fake flight plans for the Civil Aviation Authorities at the airport.

275. 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 economy 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 in Roraima with attempts to fully remove garimpeiros from Indian lands. The Yanomami situation, which involves international borders, is complicated further because of the military's concern with promoting the occupation of the frontier strip along Brazil's northern borders in the Calha Norte Project.

276. Constitutional Provisions. In Amazonia, new state and federal constitutions provide the basis for new laws affecting garimpo mining. Para's new State Constitution, passed in 1989, includes the following provisions: a) greater participation by the State and municipal government in mineral exploration, b) any environmental degradation must be recuperated according to guidelines developed by appropriate government agencies, c) garimpo areas can only be worked as cooperatives of garimpeiros. When formed, these cooperative will have mining priority in their areas.

277. The federal government, together with the State Assembly, must now write specific laws (leis ordinarias) that will actually spell out how the new laws will be applied. Although this remains to be done, the first garimpo cooperative formed to administer a mining operation was legally established in Serra Pelada during January of 1990. The fact that a rival garimpeiro cooperative is claiming rights in this area and the ability to negotiate with Mitsubishi (which may come to work the area after the garimpeiros leave) foreshadows many years of litigation once the laws are passed. In several garimpo areas, mining companies (including CVRD) still hold mining rights, a

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situation which will also have to be resolved.

278. Limiting Environmental Damage. Other efforts to control garimpo activity are primarily focused on limiting environmental contamination. One such effort is the CAMGA-Tapajos (Controle Ambiental da Garimpagem no Rio Tapajos) proposed by Para's Secretary of Industry Commerce and Mining (SEICOM). Project objectives include a) a survey of the garimpo communities designed to evaluate socio-economic conditions and the degree of environmental degradation (in particular, mercury contamination), b) set up a pilot project that will use appropriate technology to capture and amalgamate gold dust without releasing small dams in the garimpo areas that would capture gold dust without releasing mercury into the environment, c) establish programs to educate garimpeiros about their use of techniques that damage the environment, and d) promote other activities in the area such as small farming and livestock production that might be combined with garimpo activity

279. 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 both affordable, recognized by the garimpeiros as being more healthful, and provide similar profit margins in gold sales.

280. Miners prefer to amalgamate their own gold because gold buyers pay less for unamalgamated gold since it has more impurities. If the amalgamation step alone could be centralized at a higher level (being done by large buyers or government agencies) then more expensive technology with better controls could be justified. To do this, miners would have to be convinced that they are receiving the same price for their gold (minus the cost of amalgamation) as they would if they used mercury. Another alternative would be to convince miners to buy amalgamation equipment such as the closed system distiller which uses mercury but does not allow it to escape into the environment.

281. It is worth noting that many of the current papers available on the subject of mercury pollution indicate that most of the concern over mercury is focused on its negative impacts on the environment rather than a specific concern for the human populations most immediately affected, the garimpeiros. More often than not, the garimpeiros are seen as the perpetrators of ecological disaster rather than its victims as well. The paradox of this situation is that it is only through a direct and sincere appeal to this population that there exists any hope of controlling the situation.

282. Despite the serious health problems in the garimpo, there is no clear policy concerning the governments' responsibility in these areas. In 1989, the government requested development of 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).

283. Buying and Taxing Gold. The State of Para has benefited significantly from the reallocation of some federal taxes to state governments. A significant portion of state tax revenues come from large-scale mining operations like those

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at Carajas. Up until 1989, the taxation of mineral production was in the form of IUM (Imposto Unico sobre Minerais) representing 2.3% of the value produced. In 1988, the IUM represented roughly \$20.8 million for Para.

284. Gold accounts for 30% of the total value of mineral production for Para. Officially 17.4 tons of gold (32.6% of national production) valued at \$265 million were produced in Para during 1988, most of it from garimpos. Unfortunately the government still has no effective means of taxing garimpo gold.

285. For several years in the early and mid 1980s, the government attempted to purchase most of the gold produced in Amazonia. By the end of the decade, the government had recognized that it did not have the personnel to buy all the gold itself. As a result, it now licenses others to buy the gold with the understanding that they will then sell the gold to the government. Unfortunately, much gold is still sold illegally, that is, the registered buyers report only a fraction of what they take in.

286. It is not just gold that is sold on the black market. Gazeta Mercantil (1/29/90) reports that cassiterite mined in Rondonia is illegally crossing the border into Bolivia at the rate of 7,000 to 10,000 tons per year representing \$500 million in earnings.

287. Funding Garimpo Control Efforts. The primary agency dealing with garimpo activities is the National Department of Mineral Production (DNPM), which was created in 1934. Today, the DNPM is in serious financial straights and can do little of the work required by its mandate in Amazonia.

288. One proposal, supported by the DNPM, Paraminerios (Para State Mining Company), SEICOM (Secretariat for Industry and Commerce), and APGAM (Associacao Profissional dos Geologos da Amazonia) would like to see 3% of Para State's overall budget directed toward the mining sector. Specifically, they would use these revenues to develop the mining sector in Para, to support government institutions working with miners, to support the municipalities heavily involved in mining activity. In addition, these institutions would like to see the state set up a special fund to develop small mining firms using new appropriate technology, improve the level of industrialization of minerals within the state (including gold), and provide services to garimpo areas.

**Annex V
Forest Product Extraction**

Introduction

289. Extraction of natural products from the forest was the traditional base of the Amazon economy since the early period of contact with Europeans. It is also promoted by many as the alternative to the current process of land use changes. This section will explore briefly the history of forest extraction in the Amazon and sketch out the main limitations to its future economic vitality.

290. 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. Because of scarce labor supplies, first Indians and later poor Northerners 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.

291. When world markets declined, as they did when rubber seeds were smuggled out of Brazil to form British-controlled plantations in southeast Asia, boom economies turned to busts. 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 the survival of many forest dwelling people.

292. For all the negative aspects of the extractive economies described above in terms of standard of living and quality of life of their participants, the "environmental" consequences were relatively benign. In general, these enterprises can only survive through the preservation of the species which produced the latex, fruits, or nuts on which they depend. On the other hand, when partial destruction or complete removal of the economically-valuable species is involved in the process (harvesting of lumber and palm heart, for example), extractivists, under pressure to increase production, have shown themselves capable of depleting the forests on which they depend. In general, the risk of destruction and over-exploitation is considerably less when markets are limited and when the range of items gathered is sufficiently diversified to avoid overdependence on one species.

293. 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 as part of their way of life and may 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 group primarily consists of tribal peoples. In addition, some frontier settlers, such as small farmers, may occasionally exploit some of the forest products on their land to supplement their income.

294. According to FUNAI figures, the Indigenous population of the Legal Amazon

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numbered about 129,292 in 1989. Estimates of the numbers of rubber tappers and other extractors are in the range of 90,000. Although tappers and nut gatherers can be found throughout the Amazon, the largest and best organized groups today are in Acre and Rondonia.

Constraints to the Expansion of Extractive Economies

295. In 1980, Brazilian census data (IBGE) indicated that of the 4.4 million square kilometers in the North region (Amazonian States) and Mato Grosso, only about 100 thousand square kilometers were dedicated to extraction compared to 600 thousand square kilometers dedicated to ranching and farming.

296. Agricultural census data for the North region (IBGE 1984 summarized by Fearnside 1989) indicated that over 27 different products (latex, fiber, nuts, and fruits) were collected by extractivists with a value of over \$44,213,000. At present, natural rubber (*Hevea brasiliensis* and *Castilloa ulei*) and brazil nuts (*Bertholetia excelsa*) account for almost 90% of the value of annual extraction, with rubber alone accounting for over 65% of the total value of production.

297. As shown in Table 4 extractivism has not competed well with other forms of agriculture in the Amazon. At the end of the century (1910), extractive activities accounted for over 90% of the agricultural GDP. By 1980 this share had been reduced to only 23.35%.

298. The future of natural rubber extraction in Amazonia is limited by several factors: 1) the expansion of cultivation in other parts of Brazil and world wide, 2) the production of cheaper petroleum-based synthetics, and 3) the uncertain future of governmental assistance to rubber.

299. In 1989, rubber prices in Brazil were approximately 3 times higher than the international price as a result of government attempts to protect the local rubber industry through taxation of imported rubber and subsidized 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). Nor is Brazil self sufficient for its own needs. In 1982, Brazil imported roughly half of the natural rubber it used.

300. Attempts to establish plantation rubber

Table 4

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	45.02	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	38.9*	27.10
1964	30.61	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.

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culture in the Amazon have largely failed, in part because of a leaf blight that spreads rapidly when trees are planted in close proximity. The blight does not affect plantations in conditions outside of the Amazon. The general lack of a stable labor supply has been an equally daunting problem affecting rubber plantations as far back as Henry Ford's failed attempts at Belterra and Fordilandia in the 1920s⁴⁴.

301. The fact that successful rubber plantations in Brazil outside of the Amazon (Sao Paulo and Mato Grosso) are being established adds further incentive for the government to eliminate the current rubber subsidy. Other forms of official support for extractivists (especially rubber tappers) has eroded in recent years.

302. The state of the Brazilian economy and the government's own fiscal crisis resulted in budget cuts (in 1988) to SUDHEVEA (National Rubber Promotion Agency). The following year, SUDHEVEA was merged with other agencies to form the Environment and Renewable Resources Institute (IBAMA). Rubber tappers are further distressed by the decline of 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 under the rubber promotion campaigns (PROBOR I, II, III) that attempted to ease the tappers' isolated existence and keep them from leaving strategic production and frontier areas.

303. Many traditional rural extractive areas continue to experience population decline as gatherers move to regional towns. The town of Eirunepe, in Amazonas state, 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 returns from rubber tapping continue to decline relative to the cost of living.

304. Other development efforts and changes in the frontier economy have also resulted in dramatic changes in the resource base that forest peoples depend on for survival. Rapid development, including ranching, farming, hydroelectric projects, mining, has resulted in a decline of traditional subsistence resources (fish, game, fruits, and nuts) often without benefits of development (improved service delivery, education, health care; etc).

305. It is calculated that roughly half of the population of Amazonia is now urban (Sawyer 1990) as new migrants, unsuccessful small farmers, families of gold miners, and traditional rural residents alike move to urban areas. The depopulation of rural Amazonia is part of a larger trend resulting, in part, from the high cost of distributing the benefits of development to rural areas,

⁴⁴ Following the rubber market crash in the 1920s, Ford obtained concessions in the Tapajos river basin, founding Fordilandia in 1926. In 1932 a leaf blight struck and he moved operations up river to Belterra where intensive grafting helped save the trees from the blight but increased production costs eventually forcing Ford to return the plantations to the Brazilian government (see Warren Dean, 1987, "Brazil and The Struggle for Rubber, Cambridge University Press).

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and rising expectations that urban areas will provide more options for family and self. The decline of traditional rural populations in Amazonia means that there are ever fewer people with the knowledge and willingness to collect extractive forest products. Unless there is a stable rural population with use rights and management skills, the survival and eventual expansion of extractive economies will be very difficult indeed.

Valuation Issues

306. There is little doubt today that the Amazon forest itself has considerable economic value in its fruits, latexes, nuts, lumber, fish, fibers, and animals. A number of ongoing research projects compare the economics of sustainable extraction as compared to other options that require forest removal. 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 value in nearby Iquitos, Peru earning \$322 per hectare per year. By discounting future earnings for each type of economic activity compared (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 activities⁴⁵.

307. A number of other studies have also attempted to show that extractive activities can provide viable alternatives to economic activities that involve the destruction of the forest. Hecht, Anderson, and May (1988) discuss the various uses of the babasu oil palm. A natural succession plant which grows rapidly and well on degraded lands, the nut of this palm has a variety of commercial uses from high grade cooking oil, to charcoal and animal feed. Thousands of peasants, primarily in Maranhao, 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.

308. Although there is a good deal of optimism about the potential for extractive economies, further researcher is needed since much of the work is case-specific and may not apply equally to other parts of the Amazon. Significant questions remain about the limitations of collection and transportation costs, the ability of markets to absorb increased production, and the ability to expand production of exotic forest products.

⁴⁵ It should be noted that many of the scientists involved in these studies caution that these species, if not managed properly, could be overexploited themselves or be used to replace other species (a large scale plantation of brazil nuts replacing an intact forest, for example).

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309. Although it is difficult to place a monetary value on an ecosystem that most researchers admit is poorly understood at best, careful economic valuation can help establish the opportunity cost of changes in land use from primal forest. It must be recognized, however, that an analysis which seeks to demonstrate that returns per hectare are higher in extractive uses than other uses does not make the case for extractivism. An appropriate analysis would compare returns per productive unit, including land, labor, and capital valued at their opportunity cost. In general, with land in the Amazon abundant relative to labor, an analysis calculated the returns to labor would better predict the market outcome than one which focussed on the returns to land. This, of course, is demonstrated by the market, where forest extractivism has tended to vanish wherever labor has reasonable alternatives.

Government Policy and Extractive Reserves

310. Relative to other forms of development, the government has (until recently) given scant support to extraction as a development option. In general, many progressive Brazilian policy makers over the last 3 decades have come to view the past extractive practices of rubber and brazil nut barons, with their low investments and exploitation of labor, as backward and leading to regional underdevelopment. Farming, ranching, lumbering, and mining, made possible by large government infrastructural developments, were viewed as the best way to develop the region and bring it out of its historic isolation from the rest of the nation.

311. Recently the Brazilian government has expressed a willingness to establish some extractive reserves. Existing and proposed extractive reserves today still account for a very small percent of Amazonian land area and do not include the majority of the population of extractivists. In the North region (Rondonia, Amapa, Roraima, Amazonas, Para, Acre), the Brazilian census reports that slightly less than 100 thousand square kilometers (in 92,783 establishments) were used for extractive purposes in 1981. Both existing and proposed reserves for the Brazilian Amazon comprise only about 20 thousand square kilometers (almost exclusively in Acre, Rondonia, and Amapa) with a total population of about 2,300 families (Fearnside 1989).

312. During his last days in office, former president Sarney designated over 10 thousand square kilometers in Amazonia, Acre, Rondonia, and Amapa as extractive reserves, one bearing the name of Chico Mendes, the assassinated leader of rubber tappers.

313. 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 extractivist and ranchers, the issue of title, along with the task of making these reserves viable economically, are several of the many complicated issues that remain to be worked out. IBAMA will be in charge of supervision and enforcement, along with state police.

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314. If extraction is going to help provide larger social benefits for a greater number of people while also providing a significant alternative to deforestation, extractive and agroforestry management techniques will have to be extended to populations currently unfamiliar with them (i.e. recent migrants and colonists) and they will have to be capable of providing a quality of life comparable to that available under less environmentally-sound techniques. This suggests that viable extractive activities will probably be integrated into broader systems that include other economic activities (perhaps farming on a limited scale) and that they will have to be capable of justifying the provision of public services and infrastructure that will ensure that traditional extractive populations will not be lured to urban areas.

Agroforestry

315. Agroforestry is defined as any planted or managed combination of trees with an understory of crops and/or managed pasture. In the Brazilian Amazon, agroforestry is often a combination of extensive systems mixed into native forest with relatively low labor inputs. These systems are usually found among traditional forest-dwelling communities (Indians and riverine peasants or caboclos).

316. Traditional extractive activities will not be able to absorb a major share of the poor migrant farmer population. Managed forest extraction together with appropriate agroforestry systems offer the potential of a more sustainable pattern of land use which can help restore partial tree cover to already deforested areas. The challenge will be to develop systems that are more input intensive than traditional systems (practiced by riverine peasants) and less intensive than the systems practiced by Japanese-Brazilian farmers of Tome-Acu in Para. This will involve working with natural tree succession processes while managing them to provide a faster/greater economic return to the small producer.

Markets for Extractive Products

317. Current proposals for developing extractive activities emphasize the importance of expanding the market for forest products and ensuring that a large enough portion of the benefits accrue to the rural communities of tappers and gatherers to improve their standards of living. Given the poor outlook for the Amazonian natural rubber industry, expansion of extrativism will require the development of other forest product markets. Tropical fruits and nuts are of particular importance in this regard. The markets of Amazonian cities, from Belem to Iquitos, contain a wide variety of edible fruits from the forest. A number of studies (Peters, Gentry, and Alwyn 1989; Padock and Denevan 1987; Anderson 1989; Clements 1989) attest to the relative wealth of edible fruits in the region. Calvacante (1988) documents 286 different edible regional fruits. Local entrepreneurs have already used many of these fruits to make ice creams, juices, preserves, and candies.

318. Unfortunately, the great majority of these fruits have little or no market beyond Amazonia. According to Fearnside (1989), with the exception of Brazil

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nuts, the only food products that are economically significant are the palm fruit acai (*Euterpe* spp.) with an estimated annual value of \$594,000 and heart of palm extracted 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 acai has a substantial local market in many Amazon communities.

319. In addition to the lack of market recognition (even in other parts of Brazil), many of the exotic fruits also present significant technical problems in terms of perishability, storage, and transportation. Successful artesanal marketing of regional fruits is limited to those extractivists who have relatively easy and reliable transportation to regional urban centers where product recognition is high.

Discussion and Conclusions

320. 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.

321. Prospects can not be considered bright. First, extractivism is by its nature extremely labor intensive and necessarily involves a degree of isolation inconsistent with the economic provision 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 provide the potential for a better future for their children.

322. The potential for development of markets for Amazonian forest products cannot be considered high. Almost any Amazonian product that could find a large market in North America would probably find its market invaded by competitors from other areas (California, Florida, Hawaiian Island, Caribbean Islands, Fiji's, etc.).

323. Despite the gloomy prospects for extractivism to compete 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 marketing of extractivist products in exchange for land occupation and land protection services.

Annex VI
Large-Scale Mining

Introduction.

324. Large-scale mining may be an essential element in the establishment of viable economies in the Amazon. While their direct environmental effects have been generally benign, the potential for indirect effects is large. Although a systematic assessment of the future role of mining in the Amazon is beyond the scope of this chapter, it is clear that the mineral resources of the Amazon hold the potential to sustain substantial economic activity for the foreseeable future. In Para for example, the direct and linkage effects of mining is one of the primary engines of economic growth.

325. This section will first review some of what is known concerning the mineral resources of the Amazon. Second it will briefly outline the history of the major formal sector mining activities in the region. Finally, it will review the issues concerning the direct and indirect environmental and developmental effects of the projects.

Mineral Resources of the Amazon.

326. The mineral wealth of the Brazilian Amazon is estimated at \$3 trillion with deposits of gold, bauxite, tin, copper, uranium, potassium, rare earths, niobium, sulfur, manganese, schist, diamonds, and other precious stones (Gazeta Mercantil 1/29/90). New mineral deposits are discovered each year. Last year, for example, new tin ore and gold deposits were discovered in Rondonia. Other sites, including the giant Salobo⁴⁶ copper reserve (in the Carajas range), remain to be fully explored.

327. The significant deposits of important minerals in the Brazilian Amazon have helped make Brazil an important world producer. Brazil is the third most important iron ore producer (with a 17% share of world production), climbing from 22 million tons in 1967 to 150 million tons in 1989. In 1981, Brazil imported cassiterite, by 1988 it was the world's largest producer (100% from the Amazon). The Brazilian Amazon contains 10% of the world's kaolin reserves. Brazil is third in world reserves of bauxite (90% from the Amazon).

328. Para, in eastern Amazonia, is the state with the greatest intensity of mining activity. Although only 10,400 km² (or .8% of the state's land) is actually being mined, roughly 36% of the State (449,263 km²) is under official concession to mine or prospect. Current large-scale mining operations in Para include those for iron ore, manganese, and bauxite. In importance after Para in terms of mining activity are Amazonas and Rondonia with recently exploited tin ore (cassiterite) deposits, and Amapa, with the ICOMI manganese mines begun in

⁴⁶ 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).

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the 1950s by Bethlehem Steel.

329. Within Para, the largest currently identified area of mineral wealth is the Carajas 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 Carajas range contains deposits of manganese, copper, nickel, bauxite, and gold.

Major Mining Projects

330. 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 POLOAMAZONIA (Program of Agricultural and Mineral Poles in Amazonia) provided strong support for the formal mining sector⁴⁷. Mining and associated sectors receiving special attention included: the Carajas-Itaqui iron ore and steel making scheme, the Trombetas-Barcarena bauxite-aluminium complex, and the hydroelectric schemes for the Araguaia-Tocantins region.

331. Greater Carajas Program. In 1980 government created an overall program for the development of the Carajas region, named the Greater Carajas Program (PGC) of which the Carajas iron ore mine was to be the centerpiece⁴⁸. This PGC was instituted by decree-law in 1980 with the broad objective of developing the region into a major center for mineral resource-based industries. Exemptions of income tax, manufactured products tax, and import duties to projects in the official Carajas region were granted. Of the estimated \$61.7 billion required over the period 1981-1990 to implement the PGC, \$35 billion was to go to mineral activities, with 95% of that amount going to 4 mega-projects: Carajas Iron Ore, ALBRAS-ALUNORTE, ALUMAR, and Tucuruí (described below) [Neto, Forthcoming].

332. Carajas Iron Ore Project. With full government support (through the PGC), funding, and market outlets, CVRD was able to implement much of the Carajas Iron Ore project by 1986 with a highly-mechanized open-pit mine and processing

⁴⁷ Large-scale mining in Amazonia began in the 1950s with manganese mining in Amapa 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 (Anuario Mineral Brasileiro 1988).

⁴⁸ Initial plans to exploit the Carajas 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.

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facility. By 1989, this facility was producing between 30-32 million tons of ore a year utilizing one of the largest open-pit mining operations in the world.

333. 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 infrastructure including the construction and/or pavement of 170 km of highways (PA-275 and PA-150).

334. 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 Carajas 1990)⁴⁹.

335. ALBRAS-ALUNORTE-TUCURI. ALCAN (Aluminum of Canada) discovered a large bauxite deposit in the Trombetas area of north-western Para in 1967. This \$400 million project opened operations in 1979 run by a consortium led by CVRD/MRN (Mineracao Rio Norte).

336. Consistent with the goal of PGC to maximize the regional value added of 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 Tucurui hydroelectric project on the Tocantins river. The two ventures created were Alumínio do Brasil (ALBRAS) with an expected annual production of 320,000 tonnes of aluminium and Alumina do Norte (ALUNORTE) with an estimated annual production of 800,000 tonnes of alumina.

337. The huge costs of the projects' interconnecting parts (ALBRAS-ALUNORTE-TUCURUI), low world prices for bauxite, and disagreements between the various participant organizations resulted in numerous delays. ALBRAS, for example, was expected to come into full production (320,000 tonnes of aluminium year) by 1986 but still had not reached this goal by 1989.

338. ALUNORTE's implementation was even more problematic. When the Japanese declined to invest further in the ALUNORTE refinery, the project was postponed till 1989. MRN's bauxite could not be transformed into primary aluminium by ALBRAS without the alumina from the ALUNORTE refinery. This obliged CVRD/MRN to

⁴⁹ 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, Carajas represented the single largest Bank loan to Brazil and onw 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.

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seek other outlets for their 5 million tonnes annual output of bauxite. Principal among these were ALCAN, and the Alcoa aluminium complex in Sao Luis, Maranhao (ALUMAR).

339. In order to facilitate the marketing of CVRD/MRN's bauxite through ALUMAR (Aluminio do Maranhao, jointly owned by Alcoa's Brazilian subsidiary and Shell's Billiton Metals), the government through ELECTRONORTE agreed in 1980, to supply the project with subsidized energy from Tucuruí for a minimum of 20 years. ALUMAR was subsequently inaugurated in 1984 with a refinery capacity of half a million tonnes of alumina annually and a smelter capable of producing 110,000 tonnes of aluminium annually. By 1986, annual production had increased to 200,000 tonnes of aluminium.

340. In 1990 CVRD resumed the ALUNORTE project and estimated that it would be able to start operation by 1993. It is expected to produce 1.1 million tons of alumina a year, most of which will supply the ALBRAS plant (Gazeta Mercantil 1/29/90).

Current Status of Mining Activity

341. The mining sector is strong today, especially in comparison to other sectors of the economy. In 1989 CVRD established an all-time record profit of \$734.5 million, exceeding by over 3 times that of the previous year⁵⁰. This profit was based on the exportation of 88.5 million tons of iron ore and pellets (a 7.4% increase over 1988)⁵¹. CVRD was Brazil's top exporter, accounting for 3.8% of the total \$34 billion in foreign sales (Gazeta Mercantil 1/29/90). It now appears likely that CVRD will reach full production capacity for the Carajas iron ore mine in 1990 as scheduled. This is in large measure due to increasing international demand for the high quality (66% iron content) of the Carajas hematite.

342. Alcoa do Brasil, another mining company with significant interests in the Amazon also had a very good year, showing profits of \$275 million on sales of \$800 million in 1989, the best performance in its 25-year history in Brazil. Alcoa do Brasil plans to invest \$1 billion over the next decade in Amazonia (Brazil Watch Feb. 12-26 1990).

343. Brazil lacks the capital to exploit its own mineral resources. At the same time, the 1988 constitution seeks to prevent the "internationalization" of Amazonia by limiting foreign interests to minority participation in Brazilian mining ventures and forbidding foreign participation in prospecting activities. Although foreign companies may participate in other mining venture, all projects must be Brazilian controlled. Despite this, the new Brazilian government is

⁵⁰ CVRD experienced a loss of US\$344 million in 1987, prompting predictions by some experts of a slow-down of large-scale mineral development of the region (Neto, forthcoming)

⁵¹ This figure includes CVRD's production from areas other than the Amazon, principally Minas Gerais.

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likely to find ways to allow foreign capital to play a significant role in Amazon mineral exploitation.

Effects on the Environment

344. Although large-scale mining in Amazonia generates significant amounts of wealth, it is not without environmental and social consequences, including deforestation, contamination of rivers, and disruption of local communities. Available evidence seems to indicate 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.

345. It is noteworthy that the Manganese deposits in Amapa were developed by Bethlehem Steel in the 1950s with virtually no environmental planning or safeguards. Because development in Amapa has never grown beyond mining, railway, port facility, and a small agricultural sector, however, today with less than 1% of the state deforested, Amapa has the lowest rate of deforestation in the Amazon.

346. Carajas, 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 Belem), pollution control, and regeneration of degraded areas (OED 1990)⁵². CVRD's Carajas mines have become an environmental showpiece for a government eager to respond to critics of the environmental destruction associated with Amazon development.

347. A central aspect of environmental protection in the Carajas project is the large buffer zone (where native forest has been maintained) which occupies much of the 411,000 hectare mining concession. Steps have also been taken to control water, dust, and noise pollution around CVRD's mining, transport, and port terminal. Tree nurseries have been established at both Carajas and Sao Luis (Maranhao) to help restore areas deforested during mine construction while areas been acquired by CVRD near Maraba (Para) and Buriticupu (Maranhao) for forestry research. Finally, CVRD has carried out an extensive environmental education program for its employees.⁵³

⁵² 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) are 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.

⁵³ For further information see World Bank OED Report (3/21/90) Environmental Aspects of Selected Bank-supported Projects in Brazil, Environmental Aspects and Consequences of the Carajas Iron Ore Project and CVRD's Master Plan of Environment (1989-1993).

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348. In addition to environmental protection, there was also an Amerindian component. Although its implementation was somewhat more difficult than the environmental component, it did succeed in providing important health services to Indian communities. The component was less successful in land issues including the full demarcation and removal of squatters from Indian land. There is also some concern about the continuance of project benefits in the future.

349. 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 Amapa, the Carajas range in central Para, is in an area that had already started to be developed. Although CVRD mining operations in Carajas 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 and environmental degradation in general. Much of this development would not have been possible without direct support through a variety of government development initiative, including PIN, POLOAMAZONIA, and the Greater Carajas Program.

350. In its entitled Environmental Aspects and Consequences of the Carajas 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 Carajas 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 environmental planning and control in the larger region directly and indirectly affected by these investments⁵⁴.

Charcoal Production and Pig Iron Smelting

351. Another activity associated with the development of large-scale mining in Carajas is the use of charcoal for the smelting of pig-iron from the Carajas 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 Carajas Project⁵⁵. These pig iron mills were to initially use charcoal produced from

⁵⁴ 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 carajas Project, blame for the latter must also be shared between the two (pg. 118).

⁵⁵ The establishment of pig iron based industries in the area was a part of CVRD's strategy from the outset and as a result became integrated into the Grande Carajas Program design as it developed (OED 1990; Anderson 1989).

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natural forest areas in Maranhao and Para States.

352. Currently four of the mills are operating, providing employment for thousands of workers in the region⁵⁶. Environmentalists have consistently condemned the scheme because of its contribution to deforestation (see Anderson, 1989 and Valverde, 1989). The four currently operating 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. Roughly 204,000 tons of charcoal are required to produce 240,000 tons of pig iron (a ratio of .85 to 1.0). Anderson (1989: 150) estimates that despite IBDF regulations, charcoal-consuming industries in the Carajas corridor may eventually result in the deforestation of some 1,524 km² per year⁵⁷. At this rate the area under the influence of the PGC would be deforested in 70 years.

353. 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 Brasilia.

354. The Nossa Natureza Program, announced in April of 1989, requires the companies deforesting the area to replant the trees. In addition, IBAMA requires that companies using more than 8,400 m³ of wood a year supply 40% of their own stocks. By 1995, this requirement will become 100%, though an exception will be made for companies engaging in reforestation who may continue to purchase 20% of their charcoal from other firms⁵⁸. Although 2 of the largest companies have already begun forest management projects involving the harvesting of only trees of a certain size and the replanting of certain varieties of trees in 15 year rotation cycles, ecologists like Philip Fearnside of INPA argue that the proposed size management areas does not allow enough time for the forest to regenerate (see Gazeta Mercantil February 19, 1990).

⁵⁶ The OED Case Study of Carajas (1990) calculates that 12 of the Pig iron smelters, when fully operational, would employ about 4,524 people directly (see OED Report Annex II).

⁵⁷ Estimates of the amount of forest destroyed annually to supply these furnaces (once fully operational) varies from 1,000 km² per year (Fearnside) to 2,337 square kilometers of forest (Valverde 1989). For further information see OED Carajas Case Study (page 150).

⁵⁸ One of the largest pig iron producers is beginning a venture to harvest timber from the Tucurui 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).

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Discussion: Mining, Development and the Environment

355. When the vast mineral province of Carajas was discovered over 17 years ago the area was a heavily forested wilderness. The exploitation of the mineral deposits required the construction of an 890 km railroad to the port of Sao Luis, Maranhao, the construction at the port of the largest iron ore loading complex in the world, and the building of numerous roads through the forest, with a total investment of over \$5 billion. These infrastructural projects opened up previously inaccessible lands and gave many poor the hope of employment. During this period towns with only a few thousand inhabitants grew ten fold while new towns were established in other areas⁵⁹.

356. Much of the area between Maraba, the largest regional town, and Carajas (163 km apart) was reduced from jungle to burned and cleared areas as land claimants rushed to clear half the area they were claiming. Lumber companies and gold prospectors also moved into the greater Carajas area. The area around the major iron mine eventually evolved into planned company towns and counterpart spontaneous communities⁶⁰.

357. The Carajas iron ore mine and the Greater Carajas Program of which it was a center piece, virtually transformed this region, which had previously been a traditional Amazonian economy based on fishing, rubber tapping, and Brazil nut gathering. These older extractive economies were often conducted under systems that were both primitive and oppressive, with rubber tappers and nut gatherers often bound to their employers and suppliers through systems of debt peonage.

358. Those supporting modern development via roads and mines point to this sad legacy of classic extraction and emphasize the benefits of "modern" development. Proponents of extractive economies, on the other hand, point to the fact that these economies create relatively little environmental change.

359. As discussed above, the generalized environmental impact of large-scale mining activities depends primarily on their location relative to other activities and their relationship to more generalized economic trends. Unquestionably one persons "environmental devastation" is another's "development". Amapa mining development (described above), isolated from any other economic activities and separate from broader regional development schemes, resulted in relatively little development and little environmental damage. Development of the mineral province of Carajas, on the other hand, took place within a much more economically dynamic context including an actively

⁵⁹ Between 1967 and 1989 the population of the city of Maraba grew to over 200,000 people, over 12 times its size in 1967 (Bunker 1989).

⁶⁰ The town near the mine remained a protected enclave while a second community was built by the company just outside their property. This was quickly engulfed by spontaneous migrants growing from almost nothing in 1980 to over 20,000 individuals by 1989 (Bunker, Stephen "Report on the Americas" Vol 23, NO. 1, 1989).

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expanding population base, growing rural markets, and an expanding agricultural sector, stimulated in part by POLAMAZONIA (which existed from 1974 to 1987) and later the Greater Carajas Program itself. The area has also experienced a major gold and timber booms over the past decade making this area one of the most rapidly developing areas in the whole Amazon.

360. The contrast between the Amapa mining experience and that of the PGC highlights the conflict between extraction without development and development with linkages⁶¹. While extraction along the Amapa model has often be criticised severly as failing to generate local jobs, value-added, and spin-off industries, that of the Carajas is now under attack precisely for having succeeded in this regard. Much of the OED criticism, of the Carajas project, in fact, is based on failure by the Bank and CVRD to anticipate the rate of spontaneous growth and development engendered by the project.

361. Although there has undoubtedly been "environmental destruction" associated with Amazonian mining activities and the development of the Carajas corridor, a richer and more analytically constructive vocabulary would improve our ability to formulate corrective policies and to adopt a strategy for the future. There appear to be three types of problems referred to as "environmental destruction" these can be classified as preservation problems, pollution problems, and public finance problems.

362. Preservation Problems. Preservation problems are those referred to in Chapter I--greenhouse gases, microclimatic chages, and preservation of genetic resources. For those for whom the preservation motive is powerful it is a justifications for foregoing whatever benefits may be potentially forthcoming from converting the forest to other uses. Benefits to the world of avoiding possible global warming, preventing possible climatic changes in the Amazon basin and nearby areas, and/or to conserving the world's potentially useful genetic information far outweigh any possible regional benefits. While this motive may be powerful outside the project region, it tends to have few supporters within it--direct and immediate local benefits far exceed any possible local costs arising from failure to preserve the original ground cover. As discussed in Chapter I this is a classic externality problem coupled with an unusually high degree of scientific uncertainty. The approach to this class of problems cannot be expected to be determined 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.

363. Pollution Problems. Unlike preservation problems, pollution problems are felt within the project area. They range from direct effects (dust) in the mine environment (that might better be considered an employment issue than a

⁶¹ The characterization of Amapa mining as growth without development refers only to regional development in Amapa. It is possible, even likely, that profits and/or taxes from the Amapa mine contributed development elsewhere in Brazil.

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"classical" environmental issue⁶²) to pollution of rivers and streams and endangering downstream populations. With costs and benefits internalized within the region, the possibility exists to develop appropriate systems of taxation and/or compensation.

364. Public Finance Problems. Many of the environmental problems identified in the OED report relate to the immaturity of fiscal relations in areas of sudden and spontaneous growth. As a result of the newness of the region, local tax authority is poorly developed and tax bases as yet unidentified. Institutional relationships with federal (and even state) government is as yet weak limiting access to grants and transfers. Perhaps most importantly, mechanisms for expenditure allocation and control are poorly established and often (because of the boom in activity) private sector contractors may be difficult to obtain on a timely basis. The result is the exceptionally dismal standards of urban services characterizing boom towns the world over. One of the features that is central to success in the competition among frontier cities to become growth centers is precisely the ability of their leaders to manage successfully the balance between excessive taxation and provision of essential and strategic services.

Summary and Recommendations

365. Large-scale mining will continue to be major force for economic development in the Amazon. Combined with government and agricultural production for the local market, it can be a substantial contributor to stable, integrated economies in the Amazon.

366. The role of government with respect to these emerging economies must be carefully considered, both by the Bank, and by Brazilian authorities. The potential on the frontier to waste resources in trying to anticipate the direction of forces emerging from the private sector is large, suggesting that (the federal) government only become involved in providing infrastructural services after the frontier is relatively well established. Government activity at the frontier is best 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.

⁶² 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 it would be expected that the project management unit would reduce pollution to economically optimum levels. Whether or not there is a public role to reduce pollution levels to yet lower levels than would be established under such conditions is a question over which legitimate differences of opinion can exist. The closer market approximate the neo-classically competitive model the more defensible is the argument for non-intervention.

Annex VII Hydroelectric Development

Introduction

367. Over the last decade, large hydroelectric projects have figured prominently in government efforts to develop the region. In 1980 Amazonia had only two small hydroelectric dams covering an area of less than 100 km² and producing only 70 MW. This situation changed dramatically with the construction of the Tucuruí on the lower Tocantins covering an area of 2,430 km² 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).

368. Development of the hydroelectric potential of the Amazon has been a contentious issue among environmentalists and proponents of development. The hydroelectric power potential of the Amazon basin is enormous and virtually untapped. If fully utilized the area could produce an estimated 97,800 MW (mega watts) of power, out of a total 213,000 MW estimated Brazilian hydroelectric potential (Mougeot 1990). When complete, the Tocantins-Araguaia system alone could provide as much as 15% of the nation's energy needs.

369. Only 14% of Brazil's hydroelectric potential has been tapped. Until 1995, this potential will be harnessed at an expected annual rate of 11.3 % with installed capacity rising from 34,035 MW in 1983 to 55,382 MW in 1995. 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 has grown from 83.66 MW in the mid 1960s to 2882.43 MW by 1990 (Mougeot in Hall 1990).

370. For the Amazon to achieve its full hydroelectric potential, ELECTRONORTE (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 geomorphologically poor for dams. For this reason, it is calculated that approximately 100 thousand km² would be flooded if all the dams were built. Although this does not represent a major portion of the total land area of the the Amazon, its effect on tribal people would be serious⁶³.

371. Over the last year, Eletrobras's "Plan 2010" has undergone some revision in an effort to reconcile issues of energy generation with environmental and tribal people's considerations. The 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 Amazonia that were expected to

⁶³. This represents approximately 2% of the area of the legal Amazon or the equivalent of the land set aside for reserves in Rondonia.

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have major environmental impacts⁶⁴. These alterations reduced by 6,500 MW the quantity of electricity the "Plan 2010" projected for Brazil. At the same time the energy demand in Brazil seems to be growing at a slower-than-expected rate over the last several years (Gazeta Mercantil, January 22, 1990).

Possible Environmental Consequences of Hydroelectric Projects

372. Loss of Plant and Animal Species. Many of the areas that would be flooded by proposed dams are densely forested. Others have been the site of substantial human occupation and substantial changes have taken place in land use already. Near Tucuruí, for example, at least half of the affected area was in pasture, secondary forest, and small farms. Near Balbina most of the area is primary forest.

373. In the case of Tucuruí, ELETRONORTE financed floral and faunal inventories prior to the flooding. Part of this effort was the well-publicized "Operation Curupira" which rescued animals from the rising waters. Critics of these efforts claim that it was a case of too little too late, given the huge area and the relatively small pool of qualified scientists employed. In addition, the benefits of saving animals only to dump them in areas already occupied by other animals is debateable given the stress it can produce in these niches.

374. In addition to the actual area flooded, significant changes may take place above and below the dam. Although very little is known about the actual affects of dams in dense rain forest areas with high annual levels of rainfall, there are reasons to believe that significant changes may occur over time. The reduced velocity of dammed rivers will dramatically decrease their capacity to transport sediment. Aquatic plants and animals take time to adapt to these changes. Since Amazon flood plains are not farmed extensively, one would not expect a repeat of the tragic loss of farmland fertility that occurred along the Nile floodplain as a result of the Aswan dam.

375. Siltation and sedimentation inside the reservoir area, if not controlled, can reduce the capability of a hydroelectric plant. The rate of sedimentation greatly increases as a result of deforestation in watershed of the reservoir. This may prove to be one of the primary forces for forest preservation in the future.

376. Even without extensive human landscape alteration, Amazon ecology and hydrology may undergo significant changes as a result of reservoir creation. In many natural flood plain areas of the Amazon, plant, animal, and fish species are adapted to spending up to 50% of the year in submerged floodplain areas. Around the reservoir, new areas not adapted to floodplain life will be periodically flooded as a result of only relatively small increases in the water level. An increase of 4 meters at Balbina can result in the flooding of 800 km² of forest (Junk and Nunes de Melo, 1987). Before these new areas can be

⁶⁴. The cancelled projects include the Santa Isabel, planned for the Araguaia in Para which would have flooded much of the land of the Karaja Indians.

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colonized by flood-resistant communities, many species may die, creating the potential for increased erosion and sedimentation. Special care must also be taken when special biological reserves, such as river beaches where endangered turtles breed, are threatened by hydroelectric dams.

377. Most economically-valuable fishes in Amazonia 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 Tucurui area as a result of the Tucurui dam⁶⁵. Declining fishing stocks might be ameliorated by stocking the reservoirs with appropriate adapted species, although controlling and anticipating the environment within these reservoirs is a very difficult undertaking.

378. Decline in Water Quality and Health. A major problem with dams in previously forested areas has to do with problems related to the decomposition of the vegetative matter. Because most trees and vegetation is often not cleared prior to reservoir flooding, large amounts of methane, produced during the anaerobic decomposition of vegetative matter, accumulate and can explode in the dam's turbines. In addition, decaying vegetation increases the acidity of the water and accelerates corrosion of turbines and other dam equipment (see Junk and Nunes de Mello 1987).

379. Dams in tropical areas often experience increased temperatures at lake bottoms changing the life zones where species can flourish. The creation of lake reservoirs can also provide extended breeding grounds for the vectors of a number of diseases affecting human populations including malaria, schistosomiasis, and other intestinal parasites.

380. The Loss of Potential Sources of Natural Resources. Flooding of extensive areas can limit access to valuable natural resources including mining areas and timber resources. Vast amounts of usable timber were flooded at Tucurui even though a state-owned company CAPEMI was given a concession to log the area. It was felt that if logs were not removed they would present a real danger for power station turbines. Later it was alleged that CAPEMI cleared little wood, used dangerous defoliants in last ditch attempts to clear some areas, and were never able to explain the disappearance of substantial sums of money they had been advanced for their work.

381. It is estimated that there are between 40 and 60 m³ of commercially usable timber per hectare in the area flooded by Tucurui (Junk and Nunes de Melo, 1987). Today ELETRONORTE estimates that 6 million m³ of quality hardwood still lies in the lake bed. Currently some of this hardwood is being harvested with specialized equipment since much of it has been preserved under the lake⁶⁵.

⁶⁵. 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 unfortunately not included for the Tucurui dam.

⁶⁶ At the Balbina dam, no company was apparently ever contracted to harvest the lumber.

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Planned Hydroprojects and the Disruption of Human Populations

382. 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 arrive at accurate figures for the resident population of proposed reservoir sites. 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.

383. In addition to the displacement of people actually living in the area of the proposed reservoir, other populations will be affected as those that are displaced move to other areas and place greater pressure on lands there.

384. Native populations are particularly at risk. In 1981, 7 hydroprojects planned or under construction throughout Brazil were to require the evacuation of at least 1 thousand square kilometers in 32 separate indian areas, 22 of which were located in Amazonia (Aspelin and Coelho dos Santos 1981). Tukurui reportedly encroached on three indigenous reserves and affected at least 6 tribal groups (Mougeot 1990).

385. Appropriate resettlement in the case of poor rural subsistence farmers and tribal peoples (the bulk of the Amazonian populations affected by river impoundment) will involve more than simple compensation. Since native peoples are usually adapted in very specific ways to local environment and poor peoples often barely make a living under the best of circumstances, these populations will require assisted resettlement, rather than individual cash compensation, in order to (at the very least) maintain previous living standards.

386. In order to guarantee the greatest measure of development benefits to those affected by large hydroprojects, these communities will have to be included in resettlement planning. This is especially true since other such projects in tropical countries have been justifiably criticized for benefitting few locally while at the same time increasing water-borne diseases and reducing the natural resource base on which local populations depend.

Policy Issues

387. 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. There is also much to be said for greater energy conservation measures, stimulated by full cost pricing, that would reduce the need for more dams.

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388. By late 1984, ELETRONORTE had identified 63 sites for hydropower-generating reservoirs in the Araguaia-Tocantins River basin and along major tributaries of the Amazon River. More recent inventories available for the Araguaia-Tocantins and Xingu basins indicate that more than half of the regional potential could be tapped through a few large schemes in these areas. It therefore seems likely that most of the flooding will be in these basins (Mougeot 1990).

389. 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 follow through with the construction of many smaller isolated reservoirs throughout the Amazon.

390. Moreover, 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: Itaipu, in southern Brazil, has a high 9 MW/km² ratio, while Tucuruí has about 3.3 MW/km² ratio. Balbina, on the other hand, only has about .1 MW/km². It is estimated that in the long run, Balbina will not even be able to supply Manaus requiring the transmission of power for somewhere like Tucuruí (Junk and Nunes de Mello 1987).

391. Eletrobras is sensitive to the great publicity their proposed hydroelectric projects have received both at home and abroad. Certainly among the most dramatic was the meeting called by the Kayapo Indians at Altamira, Para to protest plans to build the Kararao and Babaquara dams on the Xingu river.

392. The expected cancellation of 1 planned hydroelectric projects and the reassessment of another 5 projects that were expected to have major environmental impacts in Amazonia may buy time for more detailed analysis of both the negative impacts posed by large hydro projects and the means available for ameliorating this situation.

393. It is estimated that provisions for reducing the environmental and social impact of large-scale hydroelectric plants, which has been written into the new "Plan 2010" will add 15-20% to the cost of each future project. These costs could be seen as a sound investment because it reduces the costs of dealing with badly-planned projects that did not take the local communities they affected into consideration.

ANNEX VIII
A Review of Experience With Land Use Zoning

Introduction

394. Since the early 1900's land use zoning has been used by governments to influence the use of land. The rationale for zoning, implicitly or explicitly recognized, is that the aggregation of individual responses to market and non-market incentives will not produce a pattern of land use activity that is optimal from the society's view. The purpose of zoning is to produce a land use pattern different from the pattern individuals would produce, left to their own devices. By its very nature, zoning imposes constraints on land use that are contrary to the incentives driving individual behavior.

395. Zoning alters the effective distribution of rights in land by defining specific rights in property, such as the right to develop, to be held jointly by the individual and the state, or held exclusively by the public sector. Although zoning redefines property rights in land, the exercise of rights held in the public sector is far more complex than the act of zoning itself. Public rights in privately-held property are exercised through public sector decisions that are subject to the same influences and process as other government decisions. Since the *raison d'être* of zoning is to change the land use behavior of individual, any government action in adopting or enforcing zoning regulations must contend with the incentives that cause individuals to act contrary to the zoning.

396. The success of the public sector in implementing zoning depends on the strength of the incentives that drive individual action and the strength of the countervailing political power that enforces the zoning. Zoning is most frequently used to separate conflicting land uses within a city or to guide land development in areas that are transitional to urban uses, such as the fringe setting, some individuals have very strong economic incentives to take political and legal action to thwart the zoning and develop their parcels to their maximum density (Babcock; Fischel). At the same time, a strong political constituency often supports development control as a means of preserving amenity values of existing neighborhoods (Babcock; Hagman). The outcome, the performance of zoning as an institution, is a function of the relative strength of these competing groups.

397. A second, less frequent application of zoning is to prevent development of rural open land such as forests, farmland or floodplains. Again, the purpose of the zoning is to counter the individual economic incentives to use land more intensively (e.g. convert agricultural land to developed use; convert forests to agricultural use). Yet the political constituency backing the zoning is often weak, non-existent, or not resident in the jurisdiction making the decisions on implementation of the zoning (Barrows; Ervin). The outcome of zoning as an institution is dependent not only on the political power of the backers but also on the extent to which government can reduce the strength of the incentives that

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drive individuals to intensify the use of the land.

398. The focus of this annex is the use of zoning to maintain land in an open use whether agricultural, forestry or other. The conclusion of the analysis is that rural land use planning and zoning, taken alone, are weak tools for determining land use activity in a society in which economic incentives are the major influence on individual behavior. If the incentives driving individual behavior are weak, or if the incentives are changed to be consistent with the zoning, then land use planning and zoning can have a substantial influence on rural land use activity. When incentives are weak, the key determinant of zoning effectiveness is the extent of political support at the level of implementation of zoning decisions and enforcement. If zoning policy runs counter to powerful economic incentives that drive individual behavior, the probability that rural zoning will affect land use is proportional to the extent to which other public policies are used to create economic incentives that support the zoning and/or to reduce the incentives that induce that land use behavior the zoning seeks to change. Zoning can have a significant influence on rural land use activity if combined with other public policies that change individual economic incentives.

399. Zoning, as an exercise of the police power of government, can be supported by simultaneous exercise of the taxation and expenditure powers of government, and by other creative uses of the police power. Tax policy can create powerful incentives for land use change through taxation of land or the products of land; tax incentives can support zoning policy. The power to spend can be used directly to purchase land, but the strongest effect of the spending power is often through subsidies to product prices that create strong incentives for particular types of land use, or through provision of public services that directly affect the utility of land in different uses. The police or regulatory power, the basis for zoning, is also used to set the rules by which a market system will operate. For example, land tenure law defines the rights that individuals may have in land, such as rights to water or minerals on land formerly in the public domain. The regulatory power also defines the manner in which claims to land are established, how rights are exchanged and limits on the rights of individuals in exchange or development. Any one of these rules of the market system may be an important determinants of the incentives that drive individual land use behavior. The entire range of government powers can be used to create individual incentives that are consistent with zoning policy. This paper examines the use of zoning in rural areas to prevent intensification of land use, drawing on experience with zoning in North America, Western Europe, Africa and Latin America. The paper will be divided into two main sections discussing information and planning for zoning adoption, and the determinants of zoning outcomes after adoption. In the first section the information requirements for effective zoning policy are considered, especially with reference to recent advances in computerized information systems. In the second section the effect of incentives on zoning outcome is analyzed, including the effect of the strength and distribution of incentives, the role of market distortion, and the effect of public sector incentives on the outcomes of zoning policy.

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Information and Planning Systems

400. Land information can assist in making informed zoning and land policy decisions, but cannot prevent mismanagement or wrong decisions. Land information systems can be designed to provide information such as delineation of unique natural areas; infrastructure location and engineering data; cadastral information relating to properties or zones; and socio-economic information including statistical and census-type data. (Dale, 1988).

Land information systems include both cadastral, or parcel systems and more general types systems including Geographic Information Systems (GIS). Criteria for judging the suitability of a land information system are simple, degree of capital versus labor usage, ease of use by land owners and others, cost, degree of integration with other data systems, and flexibility in precision standards and comprehensiveness of information (Barnes, 1988).

401. Cadastral Systems. Parcel based information is usually organized around a proprietary land unit with the purpose of providing data on land ownership, value, and use, sometimes as an input to land registration programs. Three common types of cadastral systems include juridical cadastre which is the legally recognized record of land tenure, the fiscal cadastre which includes both of these as well as other parcel related information. The multipurpose cadastre system is particularly useful in situations where private property rights are not recognized or areas of occupation cannot be identified (Dale, 1988).

Multi-purpose cadastre systems are similar to general land information systems except for the parcel focus. A multi-purpose cadastre might contain data on land rights and restrictions, land values and tax assessments, rural and urban land use, structures, population and census data, administrative divisions, and perhaps cultural features. Other land data can be linked to a multi-purpose cadastre system, including topography, geological and geophysical data, soils, vegetation, wildlife, hydrology, climate, pollution, health and safety conditions, infrastructure, utility corridors, and industry and employment information (Dale, 1988).

Administrative and institutional problems are usually the most difficult to resolve in establishing and maintaining a multi-purpose cadastre. Institutions must be structured such that the establishment and updating the system is the clear responsibility of one unit but that other units share in the benefit of the system requires establishment of a cadre of highly trained technicians who must be given appropriate incentives to remain with the organization sponsoring the multi-purpose cadastre. Budget must be devoted to maintenance of the system over long periods of time (Dale, 1988).

In Thailand, a cadastre project has given priority to areas where the confirmation of land titles should help provision of agricultural credit, in areas with large amounts of undocumented land, areas with rural poverty eradication programs, and where the number of boundary disputes is high. The project has been designed to make use of existing skills and procedures by

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concentrating on those activities that have been most cost effective. Computerization has been introduced only into proven and operational systems. (Dale, 1988).

The Honduran Land titling project had a short term objective of granting fee-simple titles to farmers but experienced problems with the concurrence of various delineation and mapping activities, shortage of statistical data and the unpredictable role of politics and administrative factors. Maintenance problems were exacerbated by a commitment to extend the system to the entire country as rapidly as possible and by financial constraints. Errors were introduced because delineators did not walk boundaries with owners, supervisors were responsible for too many field teams, and individuals lacked strong incentives to produce highly accurate data. Other problems included lack of funds, competition from other institutions that traditionally performed functions of property valuation, and the opposition of large landholders (Barnes, 1988).

402. Other Information Sources. Geodetic networks establish spatial referencing and can be used for reconnaissance-level surveying, mapping, engineering, land surveying, and scientific research. Maintenance of such systems is critical and payoff is greatly reduced if the system is not updated. Field surveys can determine positions and classify features and field survey methods are essential for continuous maintenance of individual elements in a land data bank. Photogrammetry, use of aerial photographs for records and measurement, is often a preferable method if the data can be easily updated. Remote sensing gives a more complete satellite picture and is most useful in situations where a generalized level of measurement is sufficient. Data from field surveys, photogrammetry, and remote sensing can be used to from base maps to be used with cadastral information and other types of information (Dale, 1988).

403. Geographic Information Systems. Geographic Information Systems (GIS) are usually computerized systems which merge different sets of data into a spatial framework. The data can be analyzed independently or in combination (Freeland).

Micro-computer based GIS systems can be classified into four categories. The most powerful and most expensive are those which have been downgraded from mainframe computers. A second category includes those derived from commercial image-processing packages and run on a standard IBM compatible computer, which may have limitations at a country-wide planning level. Other types are dedicated microcomputer GIS packages and those developed by institutions. The latter are less expensive and are being used in several developing countries including Rwanda, the Dominican Republic, Haiti, Jamaica, and Kenya (Freeland).

The use of microcomputers to operate GIS systems has many advantages including moderate initial equipment cost, ease of learning and management, low cost maintenance and ability to share information easily. However, the cost of obtaining the data and entering it into the system may be extremely high. Experience in using these systems in developing countries has demonstrated problems such as incomplete understanding of the computing system, the possibility of diverse requirements of the system, environmental conditions, and the costs of training and staffing a system (Bell). Because most systems have

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been designed for markets in the United States and Western Europe, differences in scale, cost constraints, skilled labor and hardware support may pose difficulties in applying the systems directly in developing areas (Freeland).

404. Technology and Management Constraints. Although sophisticated information systems are extremely useful tools, their introduction requires high initial investment in equipment, and costly maintenance. Many benefits of implementing a cadastral system in developing countries may be obtainable only at a very high price. In many cases, geographic information systems have proven to be too complicated, too time consuming, and too costly (Dale, 1988).

The disadvantages of computerization also suggest caution in choosing and designing a land information system. The systems are complex, have a high dependence on capital rather than labor, and installation of computers in a poorly designed information system will usually only perpetuate the same errors and flaws as in the pre-computerized system (Dale, 1988). Other obstacles to computerization include the difficulty of handling large volumes of data, dependence on hardware and software systems, rapidity of technological change, difficulty of sustaining commitments (administrative and financial), and a shortage of skilled workers. Environmental conditions such as humidity, dust, and uncertain electrical supply may cause frequent breakdowns. Lack of skilled engineers may result in long delays before the equipment is again operational.

405. Maintenance and Training. Maintenance is a critical activity in a land information system. Initial cost estimates should reflect both system creation and maintenance because failure to allocate sufficient funds and develop a process for maintenance and updating the system will destroy its usefulness and waste the initial investment. The system for updating and maintenance must be operational from the very beginning of the project. Government must be aware not only of the size of the capital investment necessary to produce and maintain the system, but also of the length of the time in which funding will be needed before the systems can begin to return any funds through user charges. Additional maintenance costs include changes in the levels of sophistication of both the hardware and software and the training cost of increasing skills of the people operating the system (Dale, 1988).

406. Zoning and Information Systems. The level of sophistication of information is usually not the operative constraint on the implementation of zoning. In North America very effective rural zoning programs have been initiated on very little quantifiable land resources information, for example by relying on the intimate knowledge of local farmers about soil suitability for various land uses (Barrows, et al, 19XX). A more sophisticated data system may produce some minor increase in political support among groups not directly affected by the economic incentives that drive individual land use behavior, but the sophistication of the data will have little effect on the individuals who respond to economic incentives and produce the land use behavior the zoning to change. Far more important than the sophistication of the data is the degree to which public policy can reduce the economic incentives to encourage behavior that is consistent with the zoning.

407. Although a sophisticated data system does not ensure effective zoning

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implementation, the quality of the information on which zoning is based is important in designing zoning policy. One use of zoning is to direct land uses to areas in which the natural resource base can sustain the use over time. For example, zoning in the upper midwest (USA) is often used to restrict certain areas to forestry use because the soils are not suitable for agriculture. Zoning is used in southern California to prevent housing development on soils and slopes susceptible to slides. Good information on soils is essential for both uses of zoning. However, in neither case is it necessary to have a geographic information system in order to design the zoning policy and maps. Good information is essential to effective zoning; a sophisticated geographic information system may be useful but is not essential.

Incentives and Land Use Zoning

408. The decision-making process for zoning adoption varies greatly among nations. In some cases, such as in the United Kingdom, zoning decisions are highly centralized, adoption often centered at the ministry level. In contrast, zoning adoption in the United States is highly decentralized with the effective power exercised at the county or even at the township level in rural areas and at the city or village level in urban areas.

409. Although the political systems for making zoning adoption decision vary greatly, a common element is competition among groups for the economic rent that accrues to land zoned for high-intensity use, which has higher value than land zoned for low-intensity use. The zoning designation has value, which creates competition among groups seeking to acquire the higher-intensity zoning designation. For example, in North America a typical rural local government zoning decision pits real estate development interest groups, often aligned with owners of undeveloped land, against groups seeking to preserve open space or environmental areas, often allied with groups of rural homeowners who want to their amenity value in nearby open space and local farmers who want to maintain farmland in the vicinity. In suburban areas the zoning usually pits development interests against groups of homeowners wishing to protect their property values by maintaining open space nearby. On some occasions, zoning has been used to exclude low income or minority groups from the community (Fischel; Babcock). But regardless of the reason, the zoning debate arises because zoning creates gains for some groups and losses for others as government asserts a public right in privately owned or controlled property.

410. It is beyond the scope of this paper to analyze the variations in the pattern of adoption of zoning. The issue is the performance of zoning after adoption, although the reasons for variation in performance often depend critically on the groups involved in the adoption process. The general question is: Assuming that government is successful in obtaining zoning adoption, under what conditions is government successful in implementing the zoning and influencing the use of land? The question will be analyzed by examining the experience with agricultural and forestry zoning, with occasional references to floodplain and other types of rural zoning.

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Zoning in North America

411. Agricultural zoning. In North America, many provincial, state and county governments have attempted to control conversion of land from agricultural to developed uses in order to preserve environmental areas, open space, farmland or the local farm economy. The farmland preservation laws in the United States provide a good example of the interaction of economic incentives and land use restriction.

412. Many rural areas have never adopted zoning or have adopted zoning that is either high permissive or easily changed, or both. In some areas, zoning was not adopted because of landowner objection to restriction on their ability to develop land. In other areas the zoning that was adopted was highly permissive or was changed upon demand of the landowner. In many states, zoning has not been considered a viable alternative for preserving farmland because landowners and development interests have strong economic incentives to oppose adoption and implementation is difficult because these same groups can bring intense political pressure to rezone individual parcels for development.

413. The belief that zoning could not overcome strong economic incentives led many states to adopt entirely different approaches to prevent development of agricultural land. Because zoning was often ineffective and easily changed, the land market did not recognize any price effect of zoning. Tax assessments based on market value of farmland, zoned or unzoned, reflected the increasing market value of farmland for development in the post-World War II era. Rising taxes generated pressure for tax relief.

414. Beginning in 1956 in Maryland, states began to pass laws to reduce the property tax on agricultural land, based on the argument that a high property tax forced farmers off the land and encouraged urban sprawl. It was soon clear that the removal of a tax incentive encouraging development was not sufficient to prevent the conversion of farmland to developed uses. California adopted a 1965 law providing property tax reductions for farmers who agreed to keep their land undeveloped for 10 years. Farmers near cities declined to place their land under contract even though substantial property tax savings were available because the expected value of the development right (the probability of development times the likely capital gain) far exceeded the tax savings for the contract. A few counties in northern California reported good success in combining the contracts with zoning, partly because the tax reduction combined with exceptionally high-value agricultural uses of land provided a strong economic incentive for farmers to sign contracts (Gustafson and Wallace).

415. The problems with zoning and the inability of tax relief laws to influence land use led to other attempts to establish a rural land policy, exemplified by New York's 1971 Agricultural Districts Law. The authors of the law wished to control land^o use but realized that zoning would face strong political opposition based on economic incentives for land development. The Districts Law enables farmers to voluntarily form agricultural districts in which there is no zoning or other direct land use controls. Supporters hoped that prohibitions on certain public expenditures for urban services within districts would succeed in

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controlling land use. Two decades later, the law covers less than one third of New York's farmland and relatively little of the land near urban areas. The New York law uses positive incentives for farmers (tax relief, protection from nuisance suits, others) and negative incentives for development (no public services) to attempt to control land development. The package has not proven effective in countering strong land development incentives.

416. More recently, some east coast state and local governments have abandoned use of the police power and are purchasing development rights to gain some public endurance over the use of land near urban areas. The development rights purchase programs are extremely expensive and depend on landowner cooperation. To date the programs have had little effect on land use because appropriations for purchase of rights have been relatively small, although the laws are relatively new and experience is limited.

417. Vermont attempted to alter the incentives for land development by adopting a capital gains tax on land sales, the tax rate declining with increases in the length of time the land has been held prior to sale. The tax rate varies from 5 percent to 60 percent, and land held more than 6 years has no capital gains tax liability. The tax is properly viewed as an attempt to reduce speculation in land rather than as a land use control device, but the targeted group of owners had a higher probability of development than those exempted. The net effect of the law is to reduce the incentive to develop land.

418. In the upper midwest (especially Wisconsin, Minnesota, Iowa) the experience with zoning is different from that of the east or west coasts. State and local governments frequently use zoning to control development of agricultural land. For example, in Wisconsin, if county and local governments adopt strict agricultural zoning the state provides income tax credits to farmers in the zones. Farmland is exempted from assessments for urban-type services, farmers are protected from nuisance sites and special soil conservation incentive programs apply in the zones. Research to date shows widespread participation, particularly in the more densely populated counties with the better agricultural land, and strong enforcement with relatively little rezoning in most counties (Barrows). Several factors explain this successful use of zoning. First, the Wisconsin law consciously ties economic incentives to local adoption of zoning. Local officials are given a strong incentive to adopt zoning, because to refuse to adopt is to deny substantial income tax credits (average about US\$1500 per year) to their constituents. Second, the economic incentives for land development are lower, on average, than on the east coast. Third, the use of zoning is long established and politically accepted in many rural areas. Finally, in most rural areas farming is profitable, so the combined value of the tax credits and protection of their operation is larger than the relatively small expected value of the right of land development.

419. Forestry Zoning. The first use of forestry zoning in the United States was in the 1920s in the upper midwest and was designed to keep settlement out of forest areas where public services were difficult to provide and where the danger of forest fires was high. The main public service cost was transportation of children to school; given the large distances and the pauperization of county government at the time, even this minimal expenditure

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was a severe drain on county finances. The zoning was quite strict by modern standards, even providing for the removal of families from the forest zones, a program accomplished with provision of federal funds during the Depression. In many parts of the upper midwest this use of zoning continues and is an integral part of the forestry programs of state and county governments.

420. In recent years, forestry zoning has also been used to prevent development of forest land in much the same way as strict agricultural zoning has been used with farmland. In New York, part of the zoning of the Adirondack Park is designed to maintain forest use in order to preserve the natural features of the park, much of which is privately owned. In California, special forest zones are tied to provision of forestry technical assistance and special property tax relief programs. The objectives are the preservation of forest land by limiting development and the encouragement of forest management on private and non-industrial forests. The lessons, to date, are similar to those from the agricultural land cases: maintaining land in an open space use is difficult in the face of strong economic incentives for development, regardless of zoning. Success in influencing land use activity is directly related to the incentives provided by the market and by other government programs.

Zoning in Africa

421. Agricultural Zoning. The literature on use of zoning in Africa is thin, but similar conclusions can be drawn from the limited research. The use of agricultural zoning in Africa has been largely aimed at separating crop and animal agriculture, or confining agricultural activity of particular groups to specific regions.

422. Land zoning in Zimbabwe dates from a 1930 law that partitioned the land in the colony into European and African reserves, including some 7.5 million acres of land available for freehold purchase by Africans. The zoning designations were changed in 1964, but the effect of the change was to continue the pattern of settler domination of freehold tenure and the better lands, relegating the African population to other areas. This land laws were among the first targets for change with the independence of Zimbabwe.

423. More recently, Zimbabwe has established a zoning program to maintain buffer areas between national parks and traditional agricultural areas in order to reduce crop damage from wildlife and poaching for meat and ivory. The Communal Areas Management Program for Indigenous Resources (CAMPFIRE) allows indigenous groups to form companies for the joint management of resources within the buffer zone. Observers report some success in implementation because of strong government support and consistency with local needs (Nyamapfene).

424. Kenya has also used zoning to contain agricultural activity to specific areas and prevent land use conflicts with national parks. The Amboseli Group Ranch scheme promised land for group ranches, compensation for wildlife grazing on the ranches, participation in the tourism activity in the parks, and public services such as schools. The program has met with limited success, in part

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because government has been unable to provide the benefits promised in the establishment of the ranches, and because the economic incentives favor continued use of the park and buffer area lands.

425. In Botswana, the Tribal Lands Grazing Policy (TLGP) established long-term private leasehold ranches in designated zones, in an attempt to reduce range degradation and stimulate commercial livestock production. The assumption was that, based on the simplistic version of the "tragedy of the commons," individuals would practice range management and maximize offtake if grazing land were privately owned. The commercial and communal zones were originally supplemented by a "Reserve Zone" that set aside land for future expansion of livestock activity by those who had no cattle at establishment of the scheme. The zoning itself was flawed by the assumption that large areas were devoid of population--in fact the areas set aside as commercial ranches were inhabited by hunting and gathering groups that were displaced by the zoning and the introduction of large numbers of cattle into the commercial ranch areas.

426. The experience in Africa with agricultural zoning suggests that zoning alone will not induce any change in land use behavior. In the absence of any enforcement mechanisms or any change in the incentives faced by individuals, zoning will have very little effect on land use activity. Conversely, if individual economic incentives are consistent with the purposes of the zoning, public policy can have some effect on land use.

427. Forestry zoning. The experience in Africa with forestry zoning parallels the experience in agricultural. Attempts to preserve forests by designating forestry zones have been unsuccessful because individuals simply ignore the zoning in pursuit of the strong economic incentives to develop forest land for agricultural use.

428. The experience of Uganda provides an excellent example of the lack of effect of zoning on land use behavior in the face of powerful economic incentives. Settlement in the forest reserves began in the 1950s under increasing population pressure on land in parts of the country. Until the early 1970s however, the reserves were generally managed effectively for forestry purposes. Since the breakdown of order in the early 1970's massive migration into the forest reserves occurred. The push from population pressure was not countered by enforcement of the forest zone boundaries. The issue for public policy today is eviction from the forest zones. The basic policy has been that evictions will occur when settlement resulted from the breakdown of order in the 1970s and where people have some hope of obtaining land elsewhere. However, unless the squatters are provided with land elsewhere, and unless alternative economic opportunities relieve the pressure on land in parts of the country, it is unlikely that encroachment in the reserves can be halted. The government faces a long and difficult process of enforcing forest zone boundaries by evicting squatters in the forest. Similar experiences are reported in Nigeria, Kenya and other African nations.

Conclusions

Zoning requires good information, but good information alone does not produce

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a successful zoning policy. Geographic information sites are useful, but not essential in developing a zoning program. Zoning requires good information, but in many cases the level of sophistication required is much less than that provided in a geographic information system.

Zoning can be an effective policy for maintaining land in less intensive uses if zoning is supported by other government policies that create economic incentives that are consistent with the zoning or reduce incentives that cause the land use behavior the zoning seeks to change. Consistent economic incentives are particularly important for agricultural and forestry zoning because lower-intensity uses frequently have no strong political constituency within the governmental jurisdiction in which the zoning regulation is enforced. In the absence of other policies that change the economic incentives faced by individuals, zoning can be effective only if the incentives driving individual behavior are weak. The key to successful zoning policy is to recognize that zoning, by its nature, is an attempt to change the behavior of individuals in their use of land. Unless the economic incentives that drive individual behavior are changed, zoning is likely to fail.

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