WILL THE AMAZON FOREST DISAPPEAR?

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" Amazonia has so many trees that no one will ever be able to destroy this forest."

A common opinion, true enough, but the fact is that Brazil's Amazon forest is being destroyed at a galloping rate and the seemingly endless expanse of trees that still exists can not delay the forest's destruction by more than a brief moment in historical terms. It is of little importance whether twenty or sixty years pass by before we come to the last tree. The essential point is the decision about what kind of world future generations will inherit: Will the Amazon forest survive?

The sharp disagreements concerning the area currently deforested in the Brazilian Amazon are partly rooted in the limitations of existing data and, more importantly, in interprestation of these data. The most important data applying to the entire Brazilian "Legal Amazon" are taken from LANDSAT satellite images. Information from these images, however, is not up-to-date and is not reliable for older deforestation. In addition, it is generally presented to emphasize the least alarming -- but also least important -- aspect of the results.

In 1980, Brazil's National Institute for Space Research (INFE) revealed a study of images of the Amazon taken in 1975 and 1978. As a result of this study, the impression became widespread that only 1.55% of the Legal Amazon had been cleared, substantially underestimating the deforestation that had occurred up to that time -- a fact one can

easily deduce from a comparison between results of the satellite study and what is known from direct ground observation. The Zona Bragantina in the state of Pará, is the best example. The 30,000 km2 surrounding the city of Bragança was completely deforested by the first decades of this century by a population of colonists that furnished food, charcoal, and other products to the city of Belém. This area alone represents almost five times the area indicated as deforested by 1975 in the state of Pará (See Table 1). One should also mention that disturbed areas that are not completely deforested (such as forests where loggers have removed the more valuable trees) are not easily identified in LANDSAT studies even though more recent reports refer to "altered" instead of "deforested areas." The areas that are disturbed but not yet deforestated are at present relatively rare in the Amazon in comparison with other parts of the world, but this situation could change.

Although studies of LANDSAT images have underestimated the extent of deforestation in the Amazon, it is still true that clearings represent only a small fraction of the region's five million square kilometer total area. However, Amazonia though large is nonetheless finite and therefore can be destroyed. This fact becomes clear when we consider the rate of deforestation indicated by the LANDSAT data, instead of being concerned only with the area deforested at any given time.

The shape of the growth curve of the deforested area is crucial -- the most dangerous tendency is for the areas to increase exponentially. The best illustration of this is inflation. Who in

Brazil ten or fifteen years ago would have imagined that prices would be hundreds of times greater today? The difficulty of intuitively understanding exponential change is great, even for we who live daily with a phenomenon such as inflation. Thus, for many people, it seems impossible that the relatively small deforested area of the Amazon today could increase within a few years to the point of encompassing the whole region. This is precisely what would occur if deforestation were to increase in an uninterrupted exponential fashion, as inflation has. The same lack of understanding caused many people to be surprised when the forests in Brazil's Central-South states disappeared in less than a generation.

To evaluate the growth curve of the deforested areas, it is necessary to measure them in successive years. In the case of the Amazon data of this type are very scarce in the case of the Amazon. The author at the National Institute of Research in the Amazon (INPA) made one attempt using the information from LANDSAT images for three areas of INCRA (National Institute of Colonization and Agrarian Reform) colonization and one area of large cattle ranches in Rondonia for the period 1973-1978. The data, published in 1982 in the journal Interciencia , suggest that the trend is better described as exponential rather than as linear.

After the report in 1980, INPE stopped monitoring deforestation in Amazonia, passing the task to a team in Brasflia at the Brazilian Institute of Forest Development (IBDF). The first results for 1980 images were released in an IBDF report compiled in 1982 (for Rondonia), and in a 1983 bulletin that included five more

federative units (states and territories) in Legal Amazonia. These data were presented by Dr. René Novais of INPE at an Interciencia Association Seminar held in Belém during the 35th Annual Meeting of the Brazilian Society for the Progress of Science (SBPC) in July 1983. The 1980 data for Roraima, Amazonas and Amapá have not yet been released.

The available information for each state or territory is graphed in Figure 1. To better visualize the trends, the horizontal axis of the graphs begins with the year 1970. We know that the deforested areas were relatively small at that time based on the RADAMBRASIL project's mosaic of radar images taken at the beginning of the 1970's. For purposes of comparison with the later LANDSAT data we can consider the open area in 1970 to be negligible, taking into account the method's inability to identify deforested areas under old second growth, as was apparent in the case of the Zona Bragantina of Pará. The fact that deforested areas really did exist in 1970 only increases the exponential rate implied by the graphs: deforestation actually rose more sharply than indicated by Figure 1, where the open areas in 1970 are considered zero. The axes are presented in the graphs extending to the year 1983, to remind the reader that the data already are out of date due to the extremely rapid pace of events taking place in the region. In fact, the deforested area today could be much larger than what the 1980 data suggest.

The results presented in Figure 1 indicate explosive deforestation -- apparently exponential -- in Rondônia, Mato Grosso and Acre. If this current tendency is maintained, these states would

be stripped of forests in 1990, 1989 and 1993 respectively. In two other states, Pará and Maranhão, the increase may not have been exponential, but it appears to be a little more rapid than a linear increase. In only one case, that of Goiás, is there any indication of a small deceleration of deforestation by 1980. For the three federative units with no 1980 data available, we should remember that two of them, -- Amazonas and especially Roraima -- have received increasing fluxes of migrants from Rondônia in the last few years. Such migration, as we will see, greatly accelerates deforestation.

Deforestation is highly concentrated in a few foci of human activity. These foci are strongly affected, while many other areas are not significantly altered. The data indicating that only a tiny fraction of the region was deforested by 1980 are therefore quite deceptive in relation to the strength of its effects in the most affected zones. The deforestation foci are concentrated along the Belém-Brasília Highway (which cuts through Pará, Maranhão and Goiás) in the states of Mato Grosso, Rondônia and Acre, in smaller areas along the Transamazon Highway in Pará, and in the SUFRAMA (Manaus Free Zone Superintendency) Agriculture and Cattle Ranching Zone in Amazonas.

The maps in Figures 2 and 3 show the spatial distribution of deforestation in the 1975-1978 period in quadrats of one degree of latitude by one degree of longitude. The original data plotted on these maps were calculated from values in the 1980 INPE report. Figure 2 shows deforested area classified by the percentage of the total area, while Figure 3 shows the classes of deforestation rates.

It must be remembered that the initial values used as bases for the rate calculations are low for many parts of the region. The maps show clearly the concentration of deforestation in the areas mentioned above.

The process of deforestation in Amazonia has two distinct components: the appearence of new deforestation foci, and the expansion of open areas inside already-existing foci. Within these foci there are distinct influences from establishment of more properties and from the pattern of deforestation within already-occupied properties. The kind of increase in deforested areas, therefore, depends on the history of any given place as a focus of deforestation and on the dominant forces affecting clearing in the area.

The formation of new foci is a process that has been strongly influenced by governmental decisions over the past decades. Construction of the Belém-Brasília Highway (BR-010) in 1960, its improvement for year-round traffic in 1967, and its paving in 1974 were significant milestones in creating the Amazon's largest deforestation nucleus. This focus increased significantly in recent years, especially in southern Pará and in northern Mato Grosso. The construction of the Cuiabá-Porto Velho Highway (BR-364) in 1965 initiated another focus, and its paving in 1984 will bring even more rapid expansion to the affected area.

Deforestation has been indirectly stimulated by the government in various locations through programs to attract new migrants from

other parts of the country, along with the establishment of settlements and the improvement of access roads. These programs have multiplied as a result of the increase in the number of federative units existing in Amazonia and the elevation of old territories to the status of states. This is because interior areas of the Amazon have almost always lent their support to incumbent governments, making it advantageous for any party in power to increase the political representation of these areas. The principal criterion for creating new territories and states is increase in population, one of the determining factors of deforestation in the Amazon. A few years ago, for example, the government of Rondônia launched a campaign in the national communications media to promote the "fertile land" there (which, in reality, represents only 10% of the area, almost all in already-occupied zones). The campaign was strongest during the time just preceding transformation of that territory into a state in 1982. In April 1983, the govenment of Roraima published paid advertizements in Brazilian newsmagazines stating: "thanks to its very rapid growth in the last four years, Roraima is almost ready to become the twenty-fourth state of Brazil." The text explained: "this dizzying expansion is due to the policy of attracting colonists. In four years -- 1979 to today -- the government of Roraima distributed no less than one million hectares of land to ten thousand families. With this, the population has more than doubled in this period."

In recent years the press has reported various government plans to create new federal territories in the southern, central and western parts of Pará and in the southwestern and western portion of Amazonas have been proposed by government authorities in recent years,

according to the press. The most active expansion front, which seems to be passing from Rondônia to Roraima, could easily provoke new foci in areas that have thus far hardly been touched by deforestation. The paving of the Cuiabá-Porto Velho Highway (BR-364) removes a great impediment to population flow to western Amazonia, thus increasing the probability that areas in the upper Rio Solimões (Upper Amazon) and Rio Negro drainage basins will no longer be the most untouched tract of forest. The spreading of deforestation foci to areas far removed from the current zones of most intense cutting, located on the southern and eastern edges of the Amazon region, would bring the Amazon as a whole into a very accelerated phase of deforestation.

Within these foci, the pattern of deforestation depends on the prevalent type of economic exploitation. In the Brazilian Amazon, the activities of small farmers planting subsistence crops are currently small relative to the clearing of large cattle ranches. In other countries in the Amazon basin, such as Peru, the activity of the small colonists has greater impact relative to that of the large landowners. But the small agriculturalists of the Brazilian Amazon have a strong impact on deforestation rates in the zones where these farmers are concentrated. Migration to the Amazon has elevated the rate of population increase to a level far above the national average, reaching the highest values in places that receive the largest fluxes, such as Rondônia. The population of Brazil's Northern region grew at 4.9% per year (continuous exponential rate) between the censuses of 1970 and 1980, compared with 2.5% per year in Brazil and 14.9% in Rondônia! In this state the deforested area increased at a rate of

37% per year between 1975 and 1980, in accord with the data in Table 1, indicating that the deforested areas reached rates even higher than the growth of the population. This suggests that an arrival of migrants explains only a part of the phenomenon of explosive deforestation.

Even so, the arrival of more inhabitants is fundamental. Deforestation patterns in 100-hectare lots in the Ouro Preto Integrated Colonization Project (PIC) in Rondônia are being observed as a part of INPA's "Carrying Capacity Estimation of Amazonian Agro-Ecosystems Project." In eighteen lots that have had only one owner over a 10-year period, the cumulative area deforested, on the average, increased linearly until the sixth year of occupation, after which it increased much more slowly. The replacement of original INCRA-settled colonists by new owners who bought lots second hand has a great impact on deforestation -- the new owners increase the pace of deforestation in the years following the purchase of the lot. A comparison between 23 original colonists and 97 new colonists in the Ouro Preto PIC indicated that in the first four years after purchasing a lot, the new owner deforests, on the average, at an annual rate almost twice as great as the original colonist. Therefore, the process of replacing original colonists with new owners, already well on its way both in Rondônia and on the Transamazon Highway, contributes to an accelerated deforestation rate in these areas.

Pasture's role in the phenomenon of accelerated deforestation is central, both for small colonists and for large land owners and

speculators. Even in INCRA areas of Rondônia where almost all of the official effort in agricultural extension, credit, and advertising is focused on promoting perennial crops, it is pasture that occupies the greatest area. For the small colonist, planting pasture is both a cause and a result of rapid deforestation. The colonist who cuts forest for an annual crop can expect only one or two harvests before the decline in yields makes continued planting of these crops on the site less attractive than the option of cutting a new area. When annual crop production is interrupted in a new field, the colonist is usually forced to choose between planting grass and temporarily abandoning the area to second growth. Other options, such as planting perennial crops, demand a much larger investment of labor and capital. Pasture offers the advantage, in comparison with second growth, of producing some income, even if only a small amount, from the cattle raised by the colonist or from leasing the field. Much more important, however, is the value that pasture grass adds to a lot's price when the land is sold. A large part of the money colonists receive as the fruit of their labors in the colonization areas comes not from the agricultural production from one year to the next, but from the eventual sale of the lot for a higher price.

Real estate speculation is one of the principal forces driving the deforestation process in the Brazilian Amazon, and pasture has a central role in this system: besides increasing the value of the land of legalized lots, deforestation followed by planting pasture is the method most often used to secure land claims. The system is used both by small <u>posseiros</u> (squatters), who are not always thinking of speculation afterwards, and by the large <u>grileiros</u> (land grabbers).

The centuries'-old legal practice for centuries in the Brazilian Amazon, is to grant the right of possession to whoever deforests a piece of land. Such rights of possession are eventually transformed into full rights of ownership. Pasture represents the easiest way to occupy an extensive area, thus considerably increasing the impact of the small population on deforestation.

Land speculation in the Amazon has given spectacular profits in recent years, far surpassing the income obtainable from agricultural production. The increase in land prices is linked to the function of real estate as well as reserve value serving to protect the investor from inflation. The prospect of reselling the land in the future makes land buyers willing to pay prices far above those that expected production could justify. Land becomes something similar to gold or rare stamps, whose value is not based on its utility as an input to production. Could it be that, in the future, the speculative values of land in the Amazon might crash, as sometimes happens with the prices of stocks? This is an important question, since the outlook for sustained production is very doubtful. The pastures introduced into the Amazon have dismal prospects for sustaining cattle production, owing to decline in the level of phosphorous and to soil compaction in addition to the invasion of non-edible secondary vegetation.

The very small reserves of mineable phosphate in the Amazon make it unlikely that the hopes of the Brazilian Enterprise for Research on Agriculture and Cattle Ranching (EMBRAPA) will be realized by improving productivity in degraded pastures in a significant

portion of the region (don't forget that the total area of the Brazilian Amazon is five million square kilometers). The possibility of this vast area being planted in perennial crops, such as cacao, is also doubtful, since the capacity of world markets to absorb production is limited. However, speculation continues without a firm basis in terms of the probable value of future production. Furthermore, the best hope of obtaining truely sustainable yields on a long-term basis, which is the forest itself, is being destroyed in the process.

Financial incentives also continue to contribute strongly to the deforestation of the region, in spite of the myth that these incentives ceased to be important following the 1979 decision of the Superintendency for the Development of the Amazon (SUDAM) to suspend approval of incentives for new cattle projects in parts of the Amazon classified as "high forest." In reality, new projects continue to be approved in the areas of "transition forest,". located in the region between the Amazon forest and the cerrado (Central Brazilian scrubland), contributing to intense deforestation in southern Pará and northern Mato Grosso. The old projects in the area of high forest continue to receive incentives for deforestation, which in most cases was still small at the time of the policy change. The policy of restricting the approval of new incentives in areas of high forest has not even always been followed: according to Fernando Campano, a member of the consulting council of the Renewable Resources Department of SUDAM, in a statement made at the Interciencia Association Symposium held in Belém in 1983, a large cattle project was approved for implantation in the state of Acre, which is completely within the

supposedly-protected high forest zone. The existence of generous governmental incentives makes it possible for many projects to continue clearing to convert forested land into pastures even after the low production of beef would have bankrupted any undertaking whose profits depended on agronomic results.

The concentration of land tenure in Amazonia also contributes to the process of deforestation. Small farmers are continually replaced by large ranchers, either through buying up adjacent properties, or by the often violent expulsion of small squatters. Deforestation increases, due both to the new owners investing more capital and to the tendency of the large landowners to plant pastures. In addition, displacement of the former occupants leads to initiating or enlarging deforestation foci in the new areas they settle.

Deforestation for subsistence production is currently of little importance in the Brazilian Amazon when compared with other factors, but it may become more significant in the future if the population continues to grow. Felling for commercial crop production occupies a larger area, even in the case of food crops such as rice that are also planted for subsistence. Loans from special financing programs have encouraged clearing, as happened in the colonization areas of the Transamazon Highway and Rondônia, for both annual and perennial crops. In assessing the motivation for the crops planted, or of the pasture that often replaces them, the speculative value of the land is inseparable from the value of the commercial production.

Because the schemes introduced are almost always unsustainable, even more deforestation occurs: production in already-cleared areas ceases even more forest needs to be destroyed. This factor is more important for subsistence production, although it also influences commercial agriculture. Besides this, like any large investment that does not contribute to the economy of the country, the implantation of wide areas of low-productivity cattle pasture is an inflationary factor.

How can these processes of Amazon forest destruction be controled? The miniscule amount of funds and personnel currently allocated to enforce the Forestry Code in the Amazon indicates that the Brazilian government is not treating the task of deforestation control is not being treated seriously. The infringement of parks and reserves is common whenever these are obstacles for new highways or other development projects (See "A Road versus a Park" in Ciencia Hoje No. 4). Once the rationality is recognized of elevating the deforestation problem to a higher position in the hierarchy of national priorities, a series of basic obstacles would still remain to solving the problem.

One fundamental problem that impedes deforestation control is the current distribution of the costs and benefits of forest destruction. The groups and individuals that profit from deforestation are generally not the same ones that pay the resulting environmental, social and financial costs. The benefits are often channeled away to outside the Amazon region. Besides this, the benefits are concentrated, while the costs are distributed among many:

this is the classic formula of the "tragedy of the commons." Under these conditions, destruction continues to be completely rational in economic terms even if the total cost were much greater than the benefits. On the other hand, some costs are concentrated, with the benefits accruing to larger and more influential groups, as in the case of land seized from indigenous tribes.

Another factor that impedes controling deforestation is that the benefits are monetary, while many of the costs, being environmental and human, are more difficult to quantify and translate in terms of money.

The fact that felling forest brings immediate profits -- in contrast to many of the costs which will only be paid by future generations -- is one of the most fundamental aspects of the problem. In the middle of the economic crisis that Brazil faced in July 1983, Rondônia, Mato Grosso and Roraima were the only federative units whose monthly income from the Tax on Circulation of Merchandise (ICM) grew more than inflation. It is probably not a coincidence that the ICM, which is considered one of the best indices of economic activity, has increased most in areas where deforestation is most explosive. This encouraging picture of immediate profits, however, should be evaluated taking into account the heavy costs that follow a long period of massive deforestation. The use of the discount rate in economic decision-making insures that the future weighs very little when compared with any immediate profits.

The discount rate problem is part of the very structure of

decision-making that renders inviable many potentially renewable systems of resource management. The discount rate -- the speed with which profits and future costs have their weight diminished in calculating the net present value of each option -- is an index that depends on the income that can potentially be earned on money in alternative investments in other places or other branches of economic activity. There is no logical connection between the discount rate and the biological rates (such is the rate of growth of a tree in the forest) that limit the rate of return from sustained exploitation of biological resources. Rational use of the Amazon forest would generate only a slow profit.

Growth of the human population in the Amazon region could also frustrate any policy designed to control deforestation. Population growth is attributed to two causes: reproduction above the mortality rate, and the entrance of new migrants. At the moment, the flow of new migrants is so strong that it greatly surpasses the impact of reproduction, but in the long term both must reach an equilibrium. The capacity of Amazonia to absorb population in a sustainable manner is very limited, and the social problems that motivate the rush of migrants to the region must be solved in the source areas themselves.

The expulsion of small agriculturalists by land concentration both in the Amazon and in other parts of the country, together with the existence of a large landless rural population, makes finding a definitive solution to the problem of deforestation extremely difficult. The land tenure system in Amazonia, which is based on deforestation, would have to be modified to make possible the use of

the forest without clearing it. Since the tradition of legalizing land claims established by means of deforestation is an important factor in alleviating the impact of extreme social inequalities and the expulsion of rural population, solutions for these problems would have to be implemented at the same time.

It is clear that the range of problems that need to be solved to slow down the racing deforestation in the Amazon is enormous. The country must face all of these problems if we are to avoid destruction of the Amazon forest. Current deforesatation rates indicate that such changes would have to be made without much delay. In the face of such a daunting array of problems, paralysis is frequent: either accepting destruction as inevitable, or considering as useless any action less extreme than a complete restructuring of society. Paralysis, whatever its rationalization, is the most certain path to a future without an Amazon forest.

MORE DEFORESTATION IN THE FUTURE

What forces, besides the current ones, could influence Amazonian deforestation in the future?

Commercial logging, which currently affects a relatively small fraction of the region, could become a substantial source of disturbance. At the moment, world markets for tropical woods are being supplied principally by destruction of forests in southeast Asia.

The Asian tropical forests are dominated by a single family of trees, Dipterocarpaceae, and almost allproduce high-quality lumber. Due to their more homogeneous character, the Asian forests are much more easily used for industrial purposes than is the Amazon forest. At the current pace, the Asian tropical forests will be extinct before the end of the century, and, according to tropical wood merchants, commercial volumes of hardwood coming from Asia could be reduced to insignificant levels by the end of the current decade. This means that the large lumber businesses, currently much more active in Asia than in tropical America, are likely to transfer their attention to Amazonia. Many forests intensively exploited by these firms are left in a heavily altered state with little chance of recuperation, even without having been cut down by clearcutting or burning. It is probable that this form of destruction will increase substantially in the Amazon. More advanced methods to take advantage of a larger number of species to make plywood, paper pulp or other wood products

would also increase the areas reached by clearcutting.

One other potential cause of destruction on the large scale in the Amazon forest is the making of charcoal. This would be the case, for example, if the plans are implemented to collect wood from the native forest to supply a steel industry in conjunction with the Programa Grande Carajás , as announced during the 34th Annual Meeting of SBPC. in Campinas in 1982 by Mr. Nestor Jost, director of the Carajás interministerial program.

In the future, deforestation due to the population concentrations associated with mining centers should increase considerably. Plans for hydroelectric projects also imply the elimination of substantial areas of forest. The hydroelectric plans seem to have given little value to the destroyed forest, as for example in the case of the Samuel dam in Rondônia and the Balbina dam in Amazonas, where the extremely shallow reservoirs will produce only about a twelfth as many kilowatts per square kilometer of forest sacrificed than in the case of the more productive Tucuruf dam in Pará.

SUGGESTED READING

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TABLE 1

Alteration of natural vegetation cover in the Amazon region*

State or Territory	Area of the State or Territory (Km^2)	Deforested Area (Km^2)*			Percentage deforested of the area of the state or territory**		
		Through 1975	Through 1978	Through 1980	Through 1975	Through 1978	Through 1980
Amapá	140,276	152.50	170.50	--	0.109	0.122	--
Pará	1,248,042	8,654.00	22,445.25	33,913.83	9.693	1.798	2.717
Roraima	230,104	55.00	143.75	--	0.024	0.062	--
Maranhão**	257,451	2,940.75	7,334.00	10,671.06	1.142	2.849	4.145
Goiás**	235,793	3,507.25	10,288.50	11,458.52	1.227	3.600	4.007
Acre	152,589	1,165.50	2,464.50	4,626.84	0.764	1.615	3.032
Rondônia	243,044	1,216.50	4,184.50	7,579.27	0.301	1.722	3.118
Mato Grosso	881,001	10,124.25	28,355.00	53,299.29	1.149	3.213	6.050
Amazonas	1,557,125.	779.50	1,785.75	--	0.050	0.114	--
Legal Amazon (total)	5,005,426	28,595.25	77,171.75	--	0.571	1.542	--

TABELA 1

BIOMASSA E ESTOQUE DE CARBONO DA VEGETAÇÃO "NATURAL" DA AMAZONIA LEGAL BRASILEIRA

		Vivo Acima do Solo				Abaixo do Solo			Folhiça e Morto Acima do Solo			
Tipo de Vegetação	Área (km^2)	Referencia	Fitomassa seca (m tonelas ha^{-1}) (a)	Referencia	Carbono (b) (G ton.)	Fitomassa seca (m tonelas ha^{-1}) (a)	Referencia	Carbono (b) (G ton.)	Fitomassa seca (m tonelas ha^{-1}) (a)	Referencia	Carbono (b) (G ton.)
Floresta Densa de Terra Firme	3.063.000	(c)	251,7	(d)	34,69	86,3	(c)	11,90	23,5 (c)	(e)	3,239
Floresta de Cerrado	1.290.520	(c)	37,8	(g)	2,20	25,2	(g,h)	1,46	7,7	(g,h)	0,450
Floresta de Encosta	26.000	(c)	198,0	(i p.53)	0,23	64,8	(i p.53)	0,08	3,15	(i p.65)	0,004
Outros Tipos de Floresta de Terra Firme	259.000	(c,j)	277,5	(g)	3,23	70,3	(g,h)	0,82	22,2	(e,h)	0,260
Campo Úmido (terra firme + inundada)	165.000	(c)	71,5	(g)	0,53	31,9	(g,h)	0,24	6,7	(g,h)	0,050
Florestas Inundadas (Várzea + Igapó)	70.000	(c)	158,1	(k)	0,50	54,2	(f,k)	0,17	3,34	(k)	0,011
Mangues	1.000	(c)	162,5	(l)	0,01	190,0	(l)	0,01	102,1	(l)	0,005
TOTAL	4.874.520				41,39			14,68			4,02

Carbono Total- 60,09 G ton.

Source: IBDF, Folha Informativa Nº 5, 1983.

* See text for explanation of why these values underestimate true deforestation.

** States that do not lie completely within the Legal Amazon.

FIGURE LEGENDS

Fig. 1 -- Deforested areas near Ji-Paraná, Rondônia, are shown in LANDSAT satellite images as green and brown patches in the red expanse that represents the forest.

Fig. 2 -- The opening of roads like the Transamazon Highway (far left) and the Cuiabá-Porto Velho Highway (above) also leads to erosion due to the torrential rains (left).

"Fig 1" (Fig. 3): Trends of increase in the areas "altered" (deforested) derived from LANDSAT satellite data (see Table 1). In the states and territories with data complete through 1980, one can see rapid growth in Rondônia, Acre and Mato Grosso. The data for 1980 have not yet been released for Amazonas, Roraima and Amapá. The beginning of the curves is shown as a broken line since LANDSAT data for 1970 do not exist (see text for details).

"Fig. 2" (Fig. 4): Classes of percentages of area deforeated by 1978 mapped in quadrats of one degree of latitude by one degree of longitude. Each class is indicated by a different color (see Key at the left). One can see the concentration of deforestation along the principal highways.

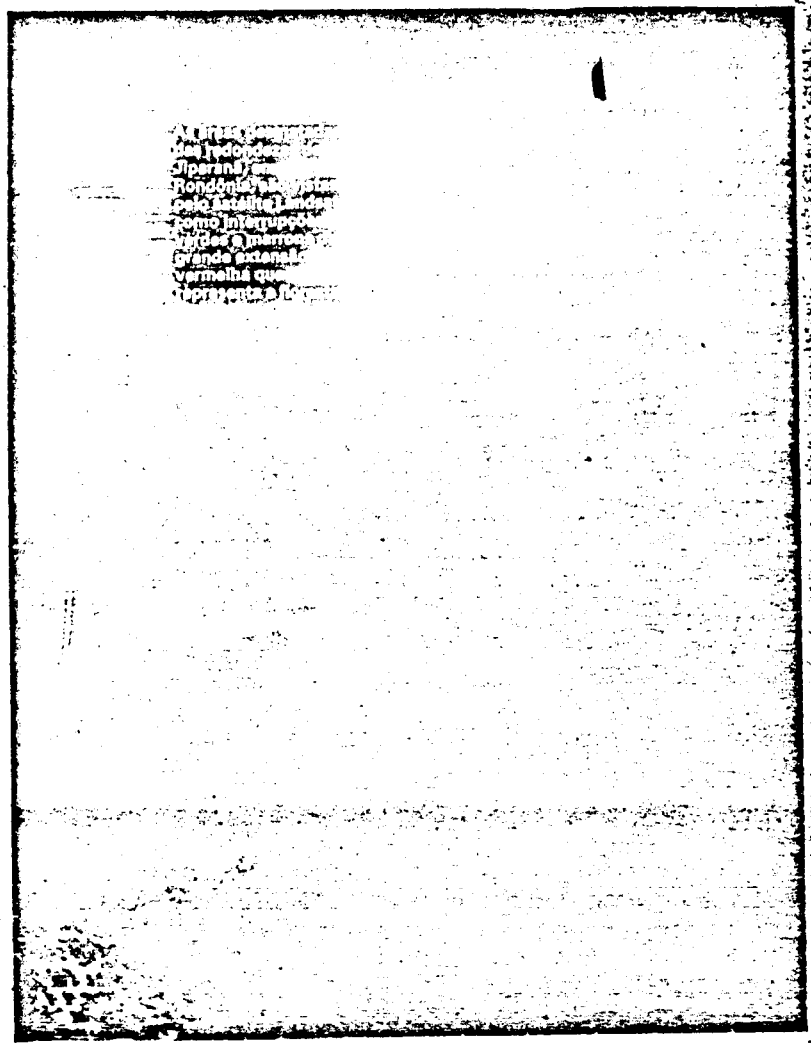
"Fig. 3" (Fig. 5): Classes of annual rates of increase in deforested areas during the 1975-1978 period, mapped in quadrats of one degree of latitude by one degree of longitude, with a color code similar to that for Figure 2, indicated at the left.

Fig 6 -- The advance of the economic frontier provokes deforestation by cutting and burning in vast areas of forest.

Fig. 7 -- The depletion of Asian forests will certainly lead multinational logging firms to come to Amazonia.

Fig 8 -- Cattle ranches are implanted through deforestation.

Fig. 1



(note: I suggest getting a different image to illustrate deforestation which focuses on the grid-like pattern of roads seen at the righthand side of this photograph)

(observação: Sugero a obtenção de uma imagem diferente para ilustrar o desmatamento, com o foco sobre a zona de linhas representando estradas vincinais, visto ao lado direito desta fotografia)

Fig. 2

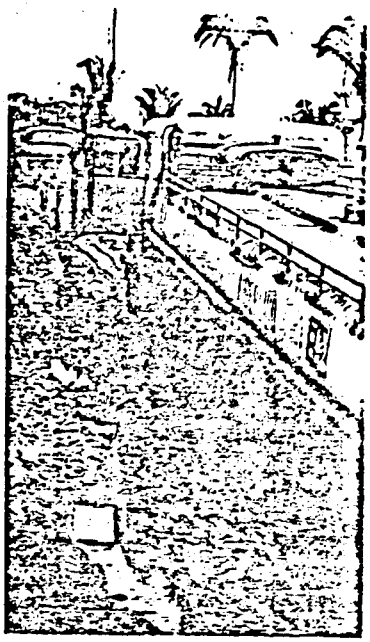


foto P.M. Fearnside

foto P.M. Fearnside

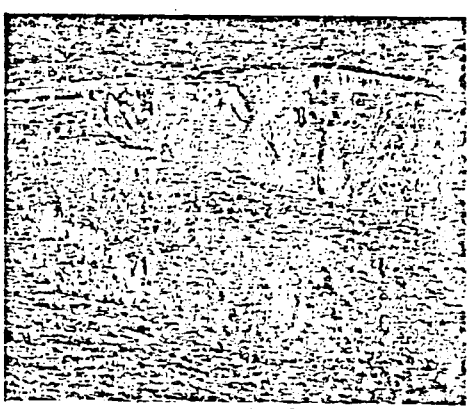
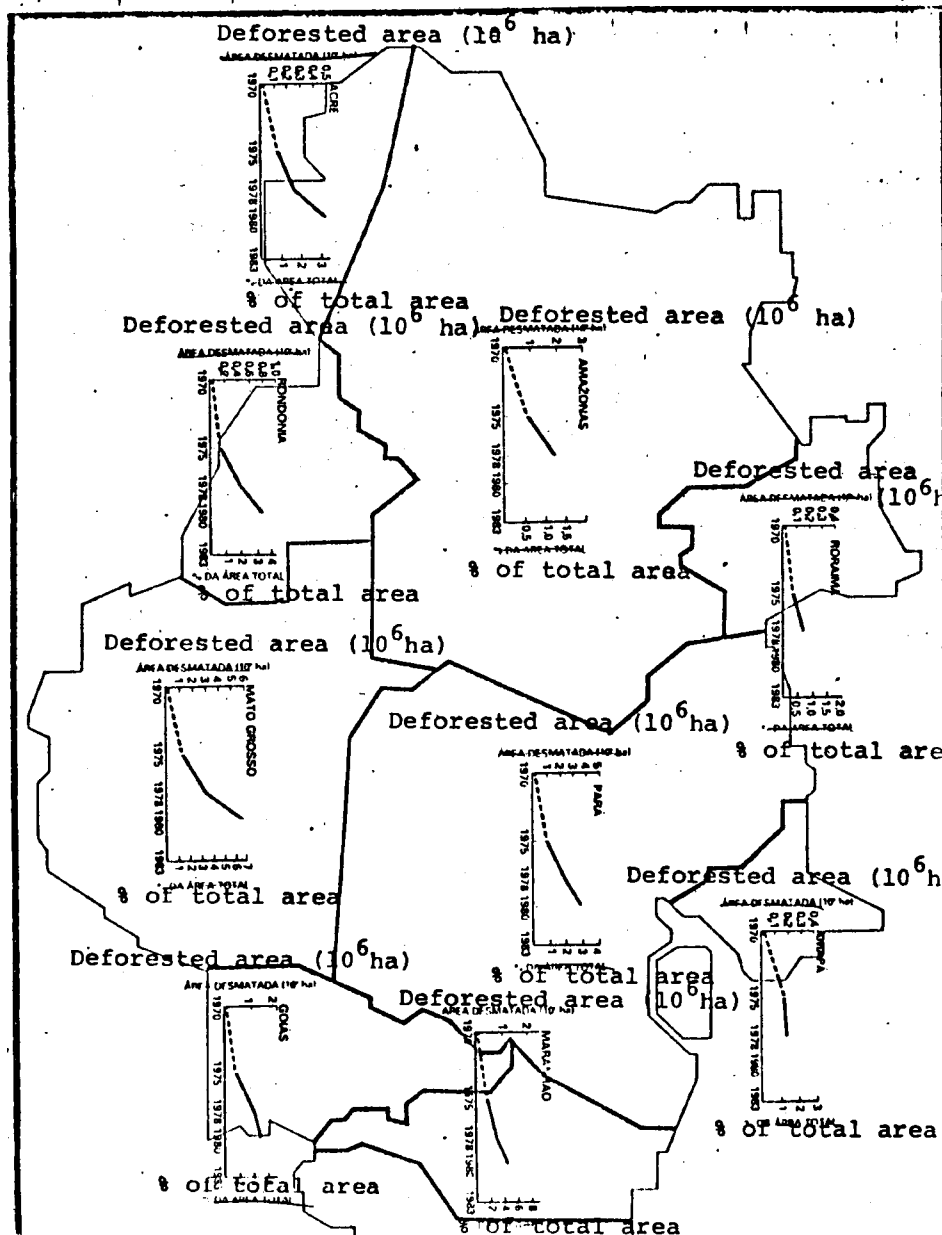
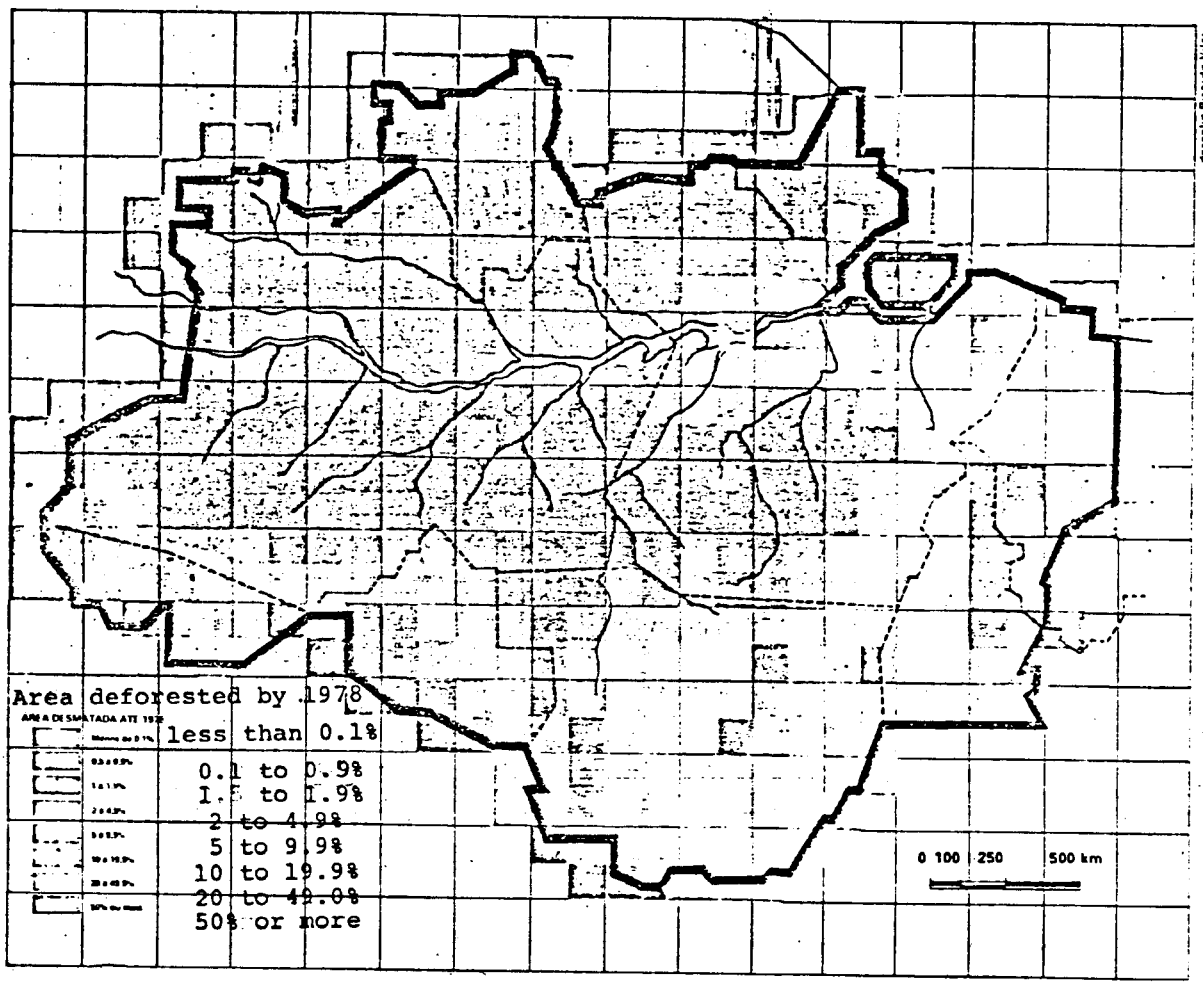


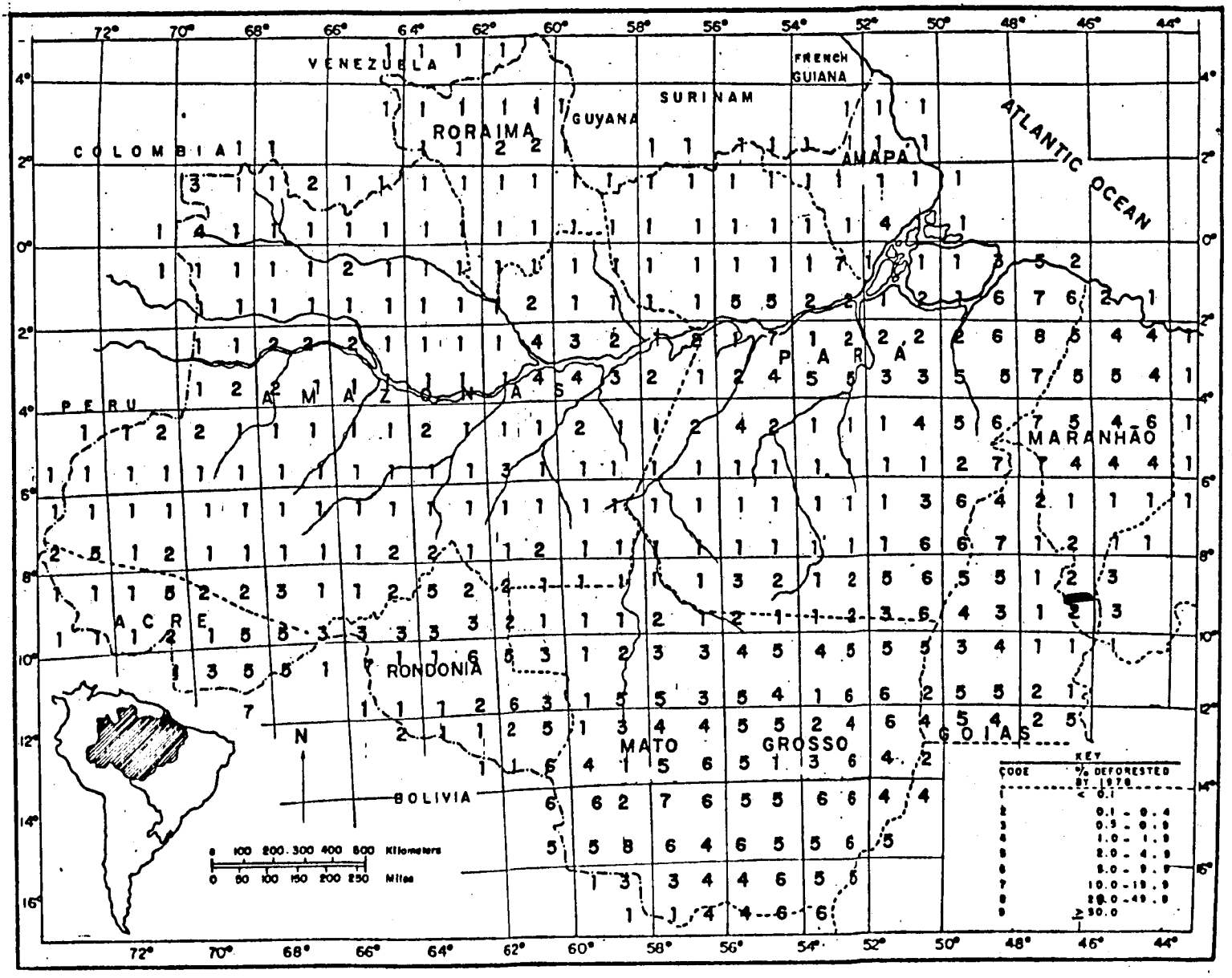
foto J. Tabacow/K. Mori/O. Bressane


Deforested area (10^6 ha)
% of total area
ACRE
Deforested area (10^6 ha)
% of total area
RONDONIA
Deforested area (10^6 ha)
% of total area
AMAZONAS
Deforested area (10^6 ha)
% of total area
RORAIMA
Deforested area (10^6 ha)
% of total area
MATO GROSSO
Deforested area (10^6 ha)
% of total area
PARA
Deforested area (10^6 ha)
% of total area
AMAPA
Deforested area (10^6 ha)
% of total area
GOIAS
Deforested area (10^6 ha)
% of total area
MARANHAO
Deforested area (10^6 ha)
% of total area
TOCANTINS
Desenho Vilma Gomes

"Fig. 1" (Fig. 3)

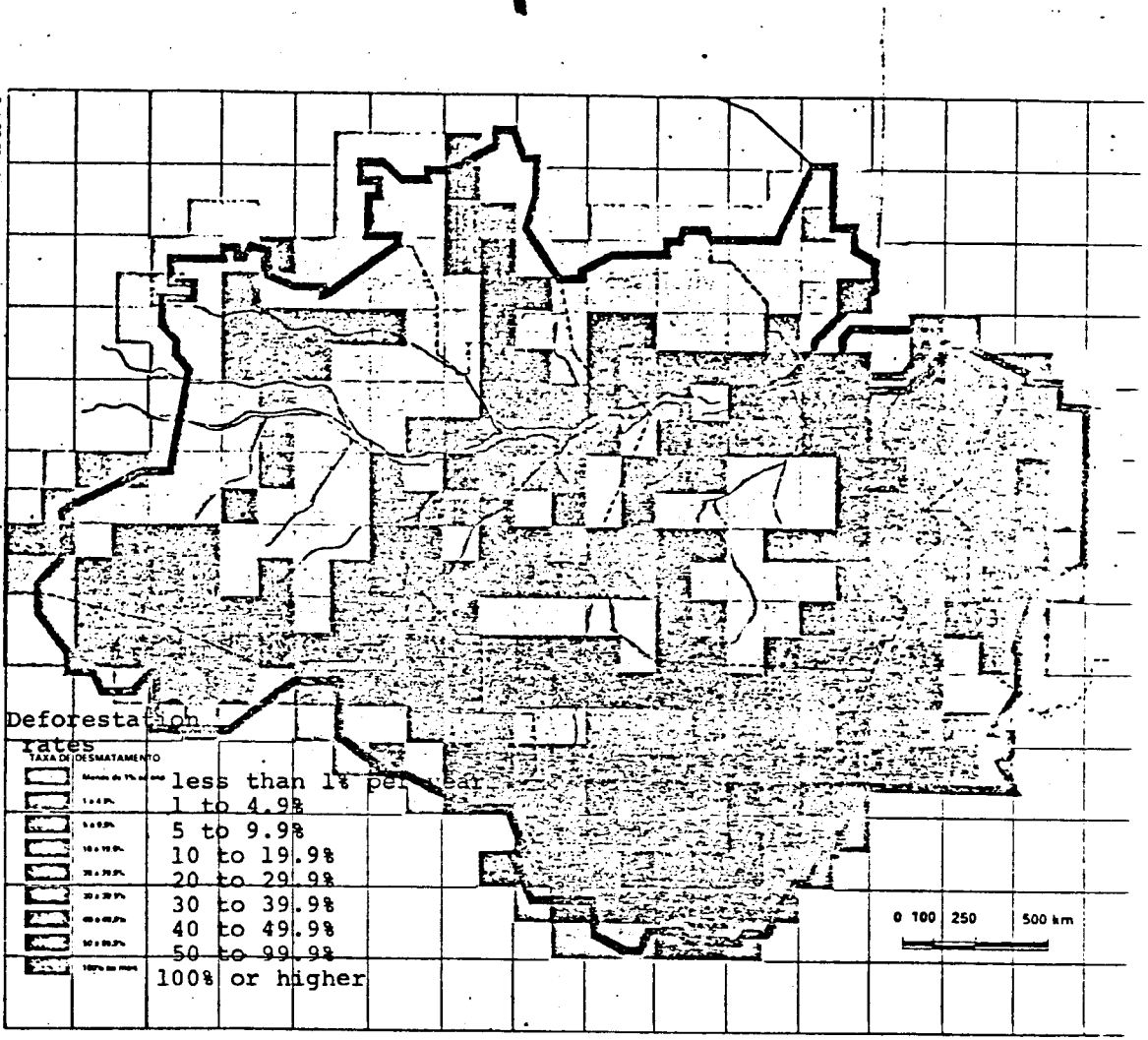
"Fig. 2" (Fig. 4)

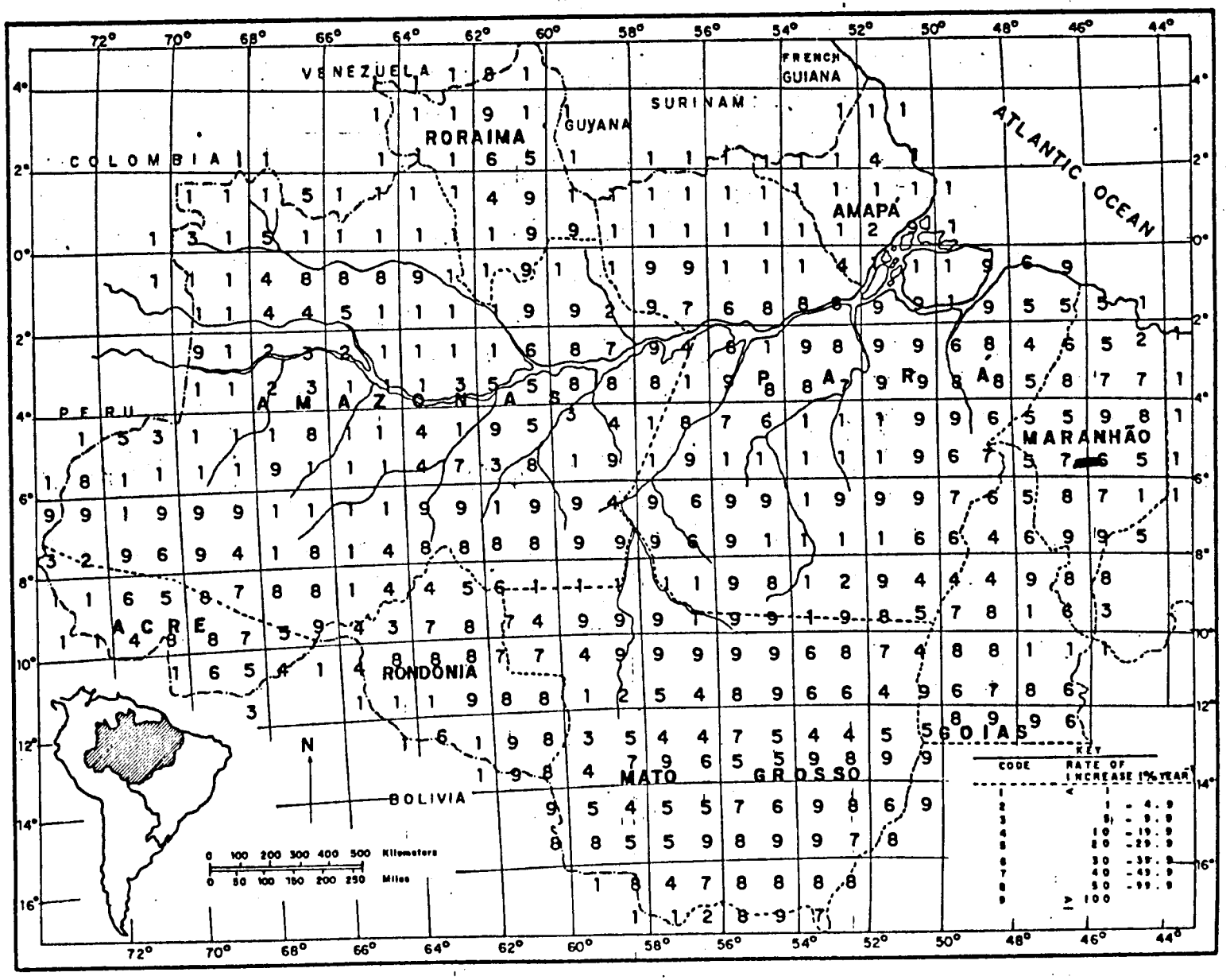

Area deforested by 1978
less than 0.1%
0.1 to 0.9%
1.0 to 1.9%
2 to 4.9%
5 to 9.9%
10 to 19.9%
20 to 49.0%
50% or more
0 100 250 500 km



Data for Fig. 2" (Fig. 4)

"Fig. 3" (Fig. 5)


Deforestation rates
TAXA DE DESMATAMENTO
less than 1% per year
1 to 4.9%
5 to 9.9%
10 to 19.9%
20 to 29.9%
30 to 39.9%
40 to 49.9%
50 to 99.9%
100% or higher
0 100 250 500 km



Data for "Fig. 3" (Fig. 5)

Fig. 6 (part 1)

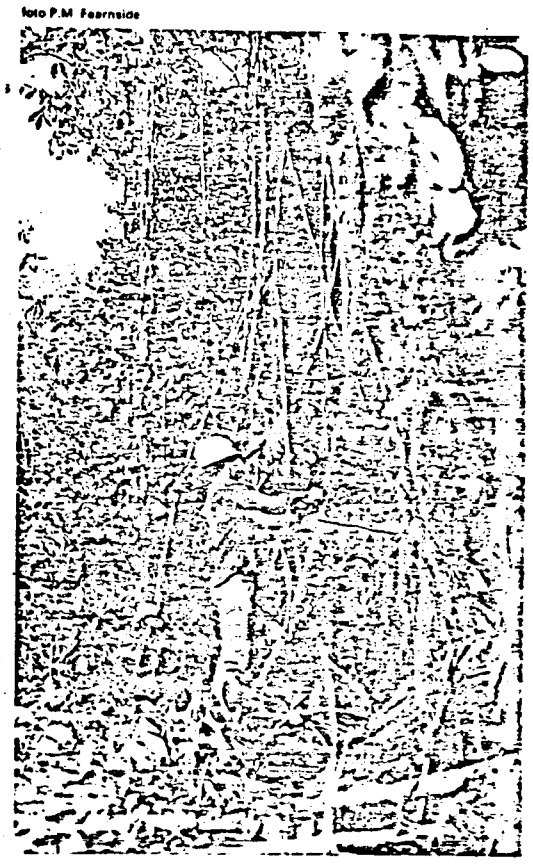


Fig. 6 (part 2)

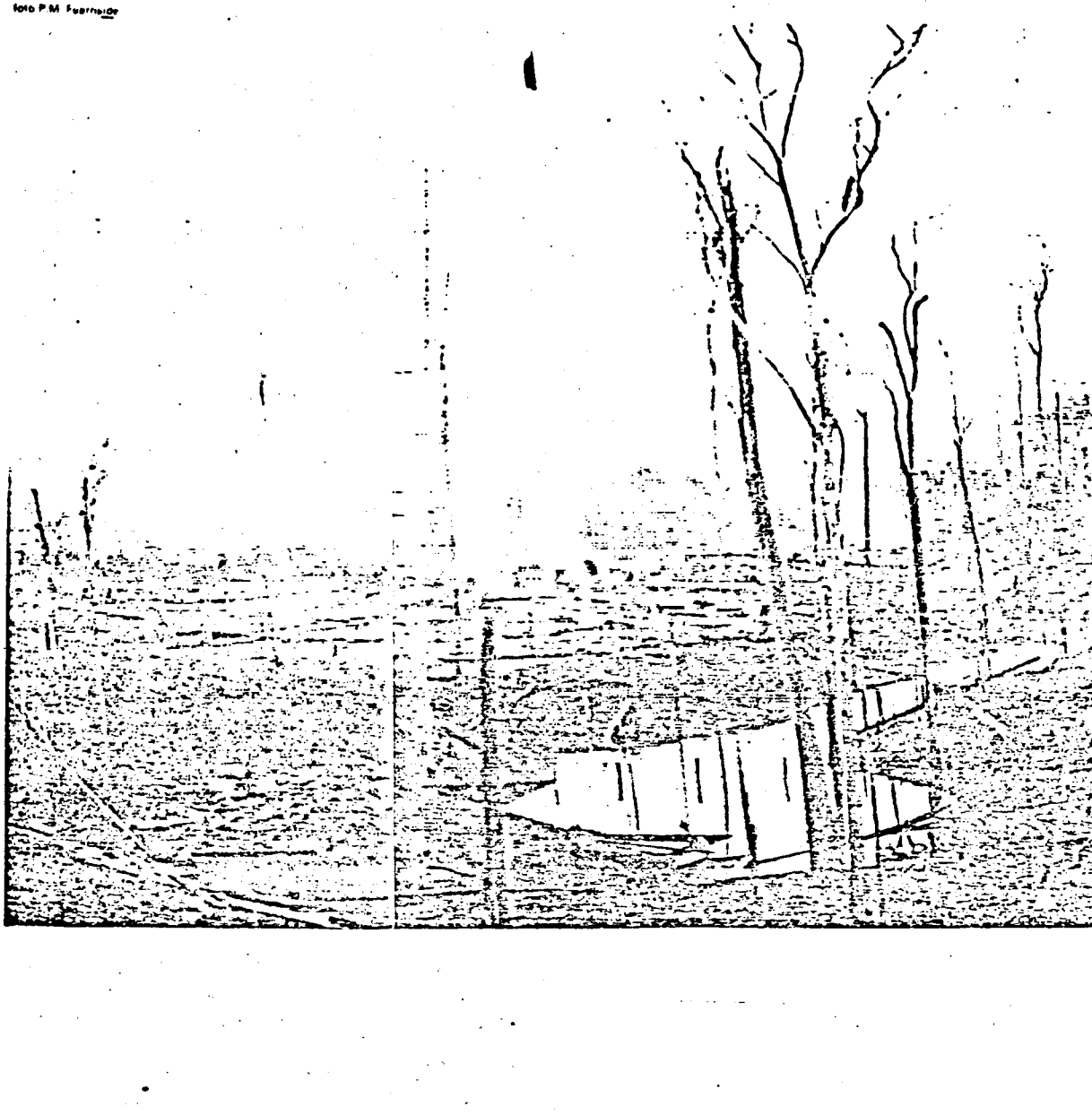


Fig. 7

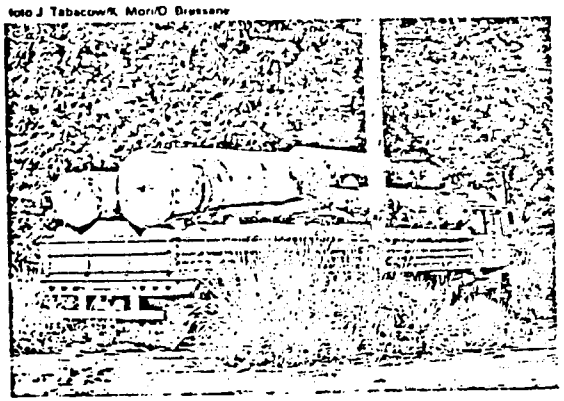


foto J. Tabacow/K. Mori/O. Bressane

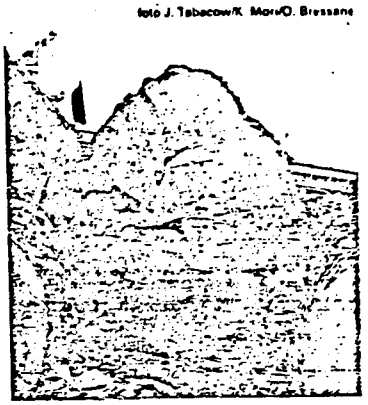


foto J. Tabacow/K. Mori/O. Bressane

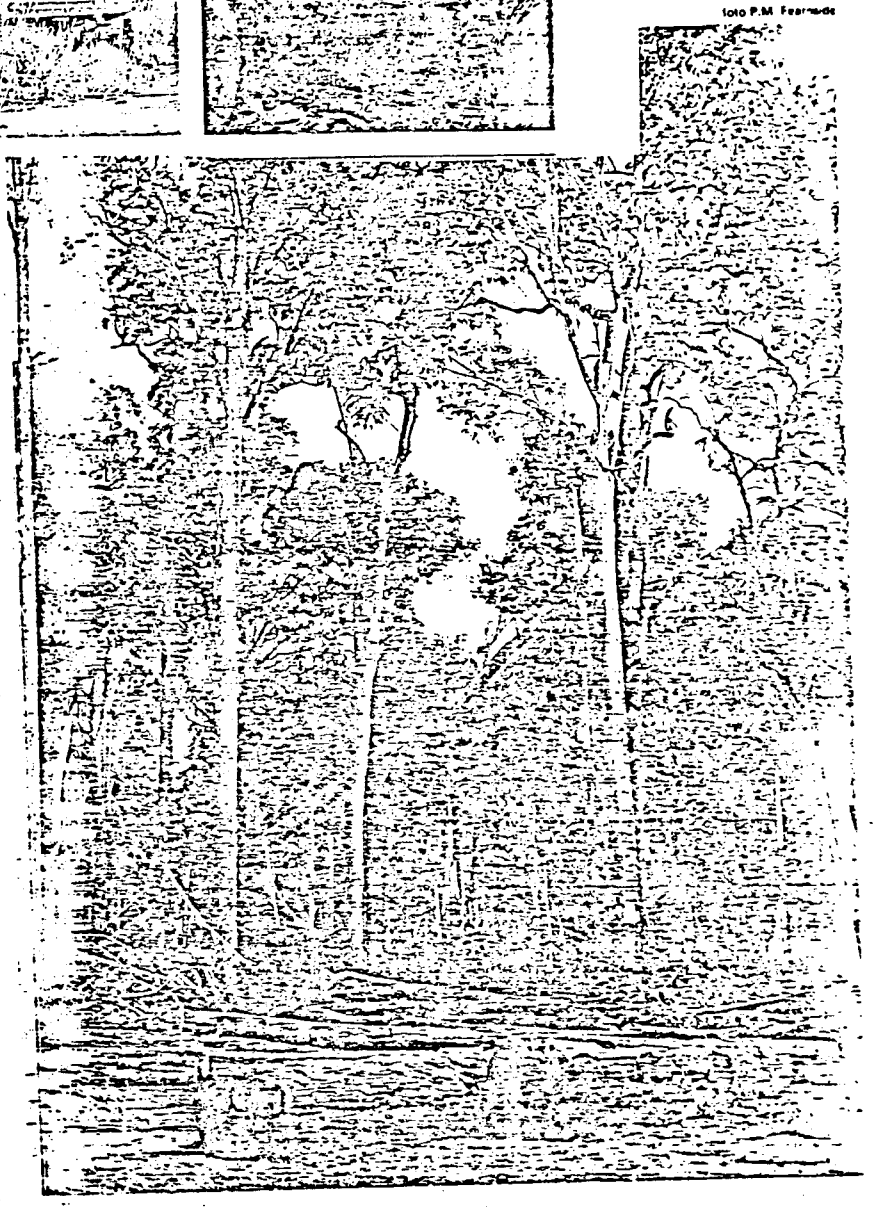


foto P.M. Fearnside

foto P.M. Fearnside