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SPATIAL CONCENTRATION OF FOREST CLEARING IN THE BRAZILIAN AMAZON

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I.) INTRODUCTION

False impressions of deforested area in the Amazon region have been generated from recent Brazilian government studies of LANDSAT satellite imagery. The press has frequently used the reports (1-4) to suggest that deforestation in the Amazon is low, and that its impact is slight at present. Both conclusions are erronious: although cleared areas are small relative to the 5 million square kilometer total area of Brazil's Legal Amazon region, they increased rapidly during the period for which data are available (1975-1980) and showed an exponential pattern over this period in several states. Because the clearings are concentrated in a few parts of Amazonia, aggregated regional data hide the great impact on natural ecosystems in these deforestation foci.

II.) THE SCALE OF VARIATION IN CLEARING PATTERNS

Patterns change greatly as statistics are successively decomposed from the level of the entire Legal Amazon to individual states or territories, to smaller units such as colonization areas or quadrats of one degree of latitude and longitude, to the smallest scale of individual lots.

Although, the regional scale, cleared areas appear small due to the domination of large uncleared areas, the faster-than-linear increase in deforested areas apparent at this scale gives ample cause for concern. LANDSAT data through 1980 are available for only six of the Brazilian Legal Amazon's nine states and territories. In the 306,792,000 ha area for which 1980 information is available (61.3% of the total area of the Legal Amazon), the cleared area increased from 0.9% in 1975 to 2.4% in 1978, to 4.0% in 1980. The last of these figures is particularly conservative because, although referred to here and in official reports as "1980" data, many of the LANDSAT images used were really from 1979. For example, to cover Rondônia, the Brazilian Forestry Development Institute (IBDF) used 45 images (including redundancy necessitated by scenes partially obscured by clouds), of these 19 (42%) were taken in 1979 rather than 1980 (4).

The availability of regional data from LANDSAT images over a span of only five years (1975-1980), severely limits the data's utility in identifying long-term trends. A longer perspective can be gained by considering what is known about the extent of forest clearing in 1970 based on information from non-satellite sources. The horizontal axis has been drawn beginning in 1970 to facilitate visualization of the approximate trend in the 1970-1975 period. Cleared area was very small in 1970, as indicated by the side-looking radar mosaic produced over several years in the early 1970's by Brazil's RADAM project (5). The trend is only slightly greater than linear from 1975 to 1980, but becomes more apparent when 1970 is considered. For purposes of comparison with the satellite data graphed in Fig. 1, the cleared area in 1970 is best assumed to be zero. Since the satellite image interpretation work used in the Government studies (Figure 1) do not register areas of old second growth (6), the fact that clearing was advanced by 1970 in some areas would not have been evident were comparable LANDSAT data available for that year. Much of the clearing by 1970 consisted of old second growth in long-settled areas such as the Zona Bragantina near Belém. To the extent that an assumption of zero clearing by 1970 underestimates the areas cleared to that date using LANDSAT criteria for "clearing" the implied exponential rates of increase over the 1970-1980 period are conservative. Adding a point at to the graphs in Figure 1 at

the origin in 1970 implies exponential growth in cleared areas everywhere except Goiás and Amapá. The horizontal axis in the Figure 1 graphs has been extended to 1983 to allow visualization of possible continuation of these trends that year.

At the level of individual states or territories, great differences can be seen in both the rate and the trend of deforestation. The available data have been graphed in Fig. 2. No data for 1980 are available for Amazonas, Roraima or Amapá. Of the remaining six states and territories, two categories emerge: a group of three states with a strong exponential pattern in deforestation (Rondônia, Acre and Mato Grosso), and a group of three with approximately linear increase in deforested areas (Pará, Maranhão, and Goiás). Of the states in the latter group, both Pará and Maranhão showed increases in clearing a little faster than linear, while only Goiás showed any sign of a slight decrease in the rate. In all but one of the six states for which 1980 data are available, clearing has therefore been accelerating over the five year period for which explicit information is available, and has accelerated in these and other states over the approximately ten year period for which inferences can be made. The variation among federative units is clear, being greatest in of Rondônia and Mato Grosso and least in Amapá.

Brazil's 5,005,426 km^2 Legal Amazon is the area to which a variety of special government programs and fiscal incentives apply. For political reasons, its southern and eastern boundaries lie outside of the zone that is phytogeographically Amazonian (3.7 million km^2), thereby just including the cities of Cuiabá and São Luis. Upland dense forests occupy 69.9% of the Legal Amazon. The 26.9% of the Legal Amazon that is in the Central Brazilian plateau, or ”cerrado” (dry scrub savanna), is mostly in Mato Grosso, southern Pará, Maranhão and Goiás, as well as a part of eastern Rondônia. The proportionally greater advance of clearing in these areas, all located in the zone around the periphery of Amazonia, means that statistics for the Legal Amazon as a whole tend to reflect greater clearing than would data referring only to the rainforest area.

One aspect of the fine scale clearing pattern counterbalances this bias to some extent within the transitional zone between rainforest and ”cerrado”. This extensive area is characterized by interdigitation of distinct forest types, rather than a smooth gradation from closed high forest to open scrub. Dicks (7) examined LANDSAT images for 1975 and 1979 for a 10,322 km^2 area centered on Xinguara, in southern Pará, and found a strong tendency for preferential clearing of the more heavily forested patches within this transitional landscape.

The results are still more varied at the level of colonization areas or of quadrats of 1° latitude × 1° longitude. At the level of 1°× 1° quadrats, both maps of amounts cleared by 1978 (Fig. 3) and implied exponential rates of clearing over the 1975-1978 interval (Fig. 4) reveal foci of intense clearing along the Belém-Brasília Highway (BR-010) through southern Pará and Northern Goiás and along the Cuiabá-Porto Velho Highway (BR-364) through Mato Grosso and Rondônia, as well as in small intensely developed areas such as the cattle ranching area of the Manaus Free Trade Zone (SUFRAMA), the Transamazon, Paragominas-Tomé Açu and Ligação-Marabá Highways in Pará, and the ranching and settlement areas of eastern Acre. In interpreting the maps in Figs. 3 and 4, it is well to remember that growth has started from very small bases in many parts of the region.

Mapping at the resolution level of 1° latitude × 1° longitude shows deforestion foci that can be associated with known developments on the ground.

These clearing foci owe their rapid growth to different processes, depending on the location in question. Some of the foci are associated with government settlement projects (and companion areas of spontaneous squatter settlement). This is the case for several of the areas along the Cuiabá-Porto Velho Highway in Rondônia (Fig. 5). Quantification of deforestation within specific colonization areas shows rapid growth, the result of the influx of new migrants dominating statistics at this level (6). In other parts of the region where large ranches predominate, such as Mato Grosso, eastern Rondônia and southern Pará, land clearing occurs principally as a means of securing claims to property for speculative purposes (8-9).

On the level of individual lots, the pattern of clearing is quite different. In an area of government-settled colonists in Rondônia with 100 ha lots, lots which had been occupied by a single owner over a period of 10 years showed a linear increase in cleared area for the first six years, followed by a plateau when clearing proceeded much more slowly (10). Whenever a lot is sold, the first years of occupancy of the new owner are usually similar to those in a newly occupied virgin lot: rapid linear increase in cleared area, followed by a plateau. The greater financial resources and different cultural backgrounds of second owners mean that they clear a larger area per year than do the original colonists. The same patterns were also found in the first five years in individual lots in another government- directed colonization area, located on the Transamazon Highway (11).

III.) LIKELY FUTURE PATTERNS

The rapid deforestation of the recent past leads one to believe that forest felling in the coming years will also be rapid. The exponential increase will have to be modified eventually as the resources required to continue the trend to its logical conclusion become limiting, but no smooth decrease or automatic end to the explosive deforestation pattern can be predicted. Rather, infrastructure is now nearing completion to facilitate a rapid spread of deforestation to more remote parts of the region. The nuclei of intense deforestation, now located primarily around the periphery of Amazonia in Rondônia, Mato Grosso, and southern Pará, can be expected to spread to other regions as access improves. The asphalting of the Cuiabá-Porto Velho Highway, scheduled for completion in 1984 with financing from the World Bank's POLONOROESTE loan, will remove one of the major impediments to migrants. The Cuiabá-Porto Velho Highway, in existence since 1965, deteriorated steadily and dramatically in quality between the time I first traveled it in 1973 and the early 1980's. In the rainy season it has been common for groups of over 400 trucks to be stuck in ”atoleiros” (mud holes) for periods of weeks or months. Entire communities spring up around the stuck trucks, including stores, bars and brothels. Even during the dry season the 1444 km trip from Cuiabá to Porto Velho frequently takes over a week by bus, due to the abysmal quality of the road and bridges. One result of these conditions has been to slow the flow of migrants to Rondônia and the rest of western Amazonia. With the highway asphalted, a greater share of the small farmers still being expelled from Brazil's Central-South by conversion of coffee and other labor-intensive crops to mechanized soybeans and wheat will migrate to the Amazonian frontier rather than to urban slums or rural areas elsewhere.

Rapid colonization of the Amazonian frontier does result in quick profits, even if the non-sustainable land uses employed virtually guarantee that these profits will be ephemeral (12). During Brazil's economic crisis of 1983, only the areas of most explosive forest clearing did not experience a drop in collections of the government's Tax on the Circulation of Goods (ICM), considered one of the best indicators of economic activity. In June 1983,

Rondônia, Mato Grosso, and Roraima were the only states and territories in the entire country where ICM receipts, adjusted for inflation, grew rather than fell, while Brazil as a whole experienced a 11.5% real drop in ICM receipts (13). Of these, Rondônia held the honor of the highest real growth in ICM in the country.

Roraima, unfortunately one of the states and territories for which 1980 deforestation data are lacking (Fig. 1), is currently in a phase of explosive forest clearing due to migration from Rondônia. The best land in Rondônia has already been fully claimed, and a growing stream of settlers who either arrive and do not find land, or who sell their claims to wealthier late arrivals, are heading for this new frontier. The government of Roraima, which as a federal territory is controlled directly by the federal government, is actively encouraging the flow and recently paid for a series of three page advertisements in Brazil's principal weekly newsmagazines (14). The advertisement states: "This dizzying expansion is due to a policy of attraction of colonists. In four years--from 1979 to the present—the Government of Roraima distributed no less than one million hectares of land to ten thousand families. With this, the population more than doubled in the period." One might add that the Roraima government has for several years maintained contacts with the government of the state of Paraná, where land transformations have been expelling the bulk of the new migrants to Amazonia. These contacts involved financing and promoting new settlement areas in Roraima to receive population directly from Paraná.

The active government promotion of population movements to different parts of the Amazon has been closely associated with Brazilian national politics. Two of the areas so promoted later became states: Mato Grosso (created in 1979 from the northern part of the former state of Mato Grosso), and Rondônia (created from a federal territory in 1982). Roraima's advertising series boasts that "Thanks to its dizzying growth in the last four years, Roraima is practically ready to become Brazil's 24th state" (14). Brazil's Minister of the Interior outlined preliminary plans to create two additional federal territories in the western portion of the present state of Amazonas (15). Presumably, these could eventually be promoted to the status of states once sufficient development had occurred.

The proliferation of states in Amazonia has an important impact on national politics, since interior parts of the region historically have almost invariably voted heavily for the incumbent party, and the new states each send two senators to the federal legislature in Brasília.

One may anticipate a proliferation of nuclei of intensive deforestation, both as a result of active encouragement and as the consequence of individual economic initiatives and spontaneous population movements. Roraima appears to be in the process of inheriting Rondônia's role as the most explosively growing frontier, but this can easily be passed to other areas as yet relatively untouched. Within each of these areas, exponential clearing patterns can be expected to occur during the phase when initial immigration dominates the effect of already established farmers. Cattle pasture installed to secure speculative claims greatly magnifies the impact a small population can have on the forest (9). Only after settlement for several years in areas with well surveyed and documented lot
boundaries, such as the older government settlement areas in Rondônia, does clearing show any slowing from its accelerating tendency.

IV.) CONCLUSIONS

Deforestation in the Brazilian Amazon is rapid and highly concentrated. Increase in cleared areas is dominated by immigration in colonization foci such as Rondônia. Even in the absence of intense immigration, deforestation is proceeding rapidly in many parts of the region through cattle ranching expansion for speculative purposes. Only in older settled areas does clearing slow, although turnover in lot ownership continues to increase cleared areas even there. One can expect a proliferation of the foci of intense deforestation from Rondônia to Roraima, and later to other areas in the region.(16)

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CURRICULUM VITAE

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Fig. 1

Fig. 1

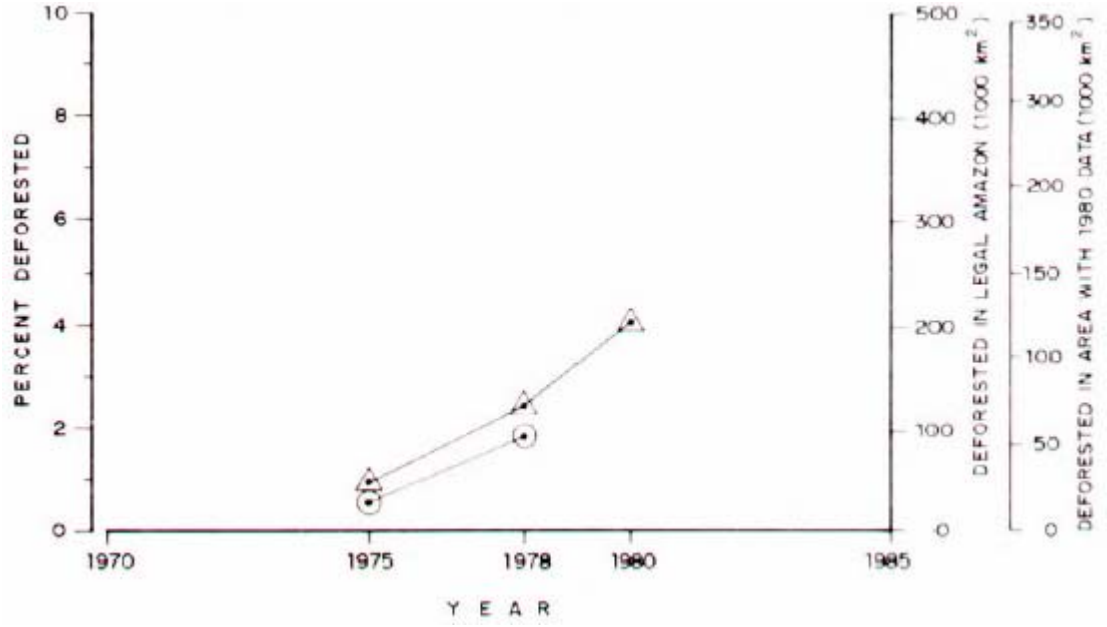
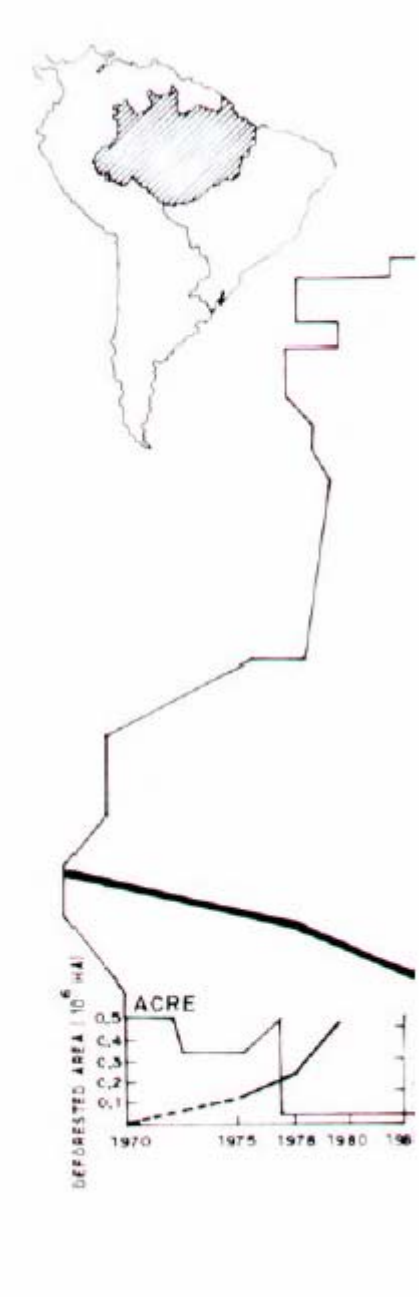

PERCENT DEFORESTED
DEFORESTED IN LEGAL AMAZON (1000 km²)
DEFORESTED IN AREA WITH 1980 DATA (1000 km²)
YEAR
0
2
4
6
8
10
100
200
300
400
500
50
150
350
1970
1975
1978
1980
1985

Fig 2 Photo

Fig 2 Photo b

Fig 2 Graph



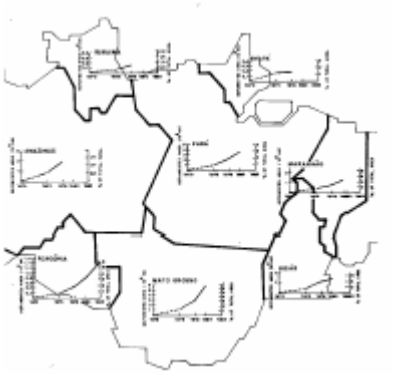


Fig 3 map

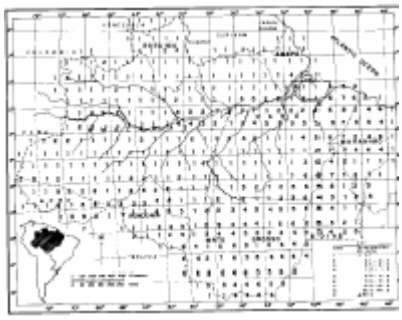


Fig. 4

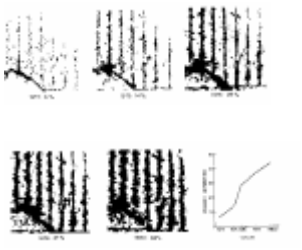


Fig. 5