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Human-Environment Interactions in
The Amazon Rain Forest

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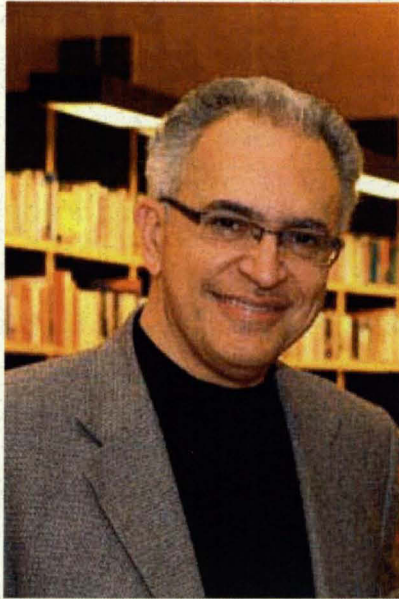
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**Human-Environment Interactions in
the Amazon Rain Forest**

Emilio F. Moran

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Human-Environment Interactions in the Amazon Rain Forest

I. Introduction

The Amazon Basin has always attracted attention because of its verdant lushness. Its vastness has motivated powerful myths (e.g. warlike Amazons, El Dorado) that have influenced how outsiders view it, treat it, and transform it. Today it attracts even more attention because of the rapidly disappearing forests cleared daily to make room for pastures and crops. The Amazon Basin is the size of the continental US, without Alaska, an area in excess of 5 million square kilometers. It is the largest extant forested area on the planet. It is also very rich in biodiversity with 20% of the planet's plant species, estimated at over 55,000. What will be the fate of the forest in the years ahead? In this lecture, I will examine the broad dynamics of human occupation of this vast region over time and whether the Amazon forest will survive past the 21st century.

During the colonial period following European discovery, the French, Dutch, Spanish, and Portuguese fought at the mouth of the Amazon for strategic control over the river. It took decades for the Portuguese to prevail over the many other interested world powers. Before the Europeans, native peoples had fought for preferred locations along the river--for more abundant

fishing areas and for periodically inundated soils that could yield a bountiful harvest (Denevan 1974).

Archeological research in the Amazon suggests that the area was occupied first by hunters chasing big game, and that by 8,000 BP there is evidence of incipient domestication (Roosevelt et al. 1991). From that time to the recent 20th century, native peoples and the Europeans who penetrated the Basin after 1500 survived by cutting forests, burning the dried vegetation, and planting a variety of crops. The predominant crop was manioc or cassava (*Manihot esculenta*), a root crop native to Northern South America that is highly productive of calories but which requires considerable processing to remove the poisonous prussic acid. In some selected regions maize and beans were cultivated, but in most of the region these two staple crops that are dominant in Central America were cultivated in only very small areas.

Many indigenous languages and ethnicities occupied the Basin and their territories shifted over time. The Tupí-Guaraní controlled the coast of Brazil, particularly the southern half, whereas the Arawak and the Carib controlled the northern half. The dominance over preferred fishing areas and better soils seems to have dictated human-environment interactions. The mythology of some populations in the Rio Negro, for example, reflects the hierarchy of this dominance—i.e., in the mythology of the order in which each people came out of the mouth of the anaconda in the origin myth (Moran 1993).

With the arrival of the Europeans in the 1500s and 1600s, one sees an effort by the Portuguese and Spanish (along the northern border with Venezuela and the Guianas) to penetrate the Amazon. They were successful along the main course of the river Amazon but, as they penetrated into the affluents, they ran into a persistent obstacle that kept any serious occupation of the Amazon from happening: the waterfalls which occur as the Guiana Shield on the north and the Brazilian Shield on the south suddenly drop off into the Amazon floodplain. The waterfalls are impassable except for some rare moments in the rainy season when water raises so high that crossing becomes possible. Thus the passage above the rapids required carrying the boats or canoes around the waterfalls in order to continue the course above the falls. This made any serious commercial activity basically unmanageable; some expeditions still took place but with very little settlement by Europeans above the falls. Most of those who made this trip above the falls were missionaries seeking to bring indigenous people to the missions for Christianization and slavers seeking to capture native peoples to be put to work on the plantations down the river.



Figure illustrating the rapids which made travel up the effluents challenging for Europeans seeking to occupy the areas above the floodplains.

Europeans brought the indigenous people to mission villages where they served as laborers, therefore facilitating their conversion to Christianity. This resulted in their decimation by disease--given their low resistance to the common cold, measles, chicken pox, and other ailments that they had had never experienced (Denevan 1974). The conditions in the mission villages were more crowded and unsanitary than the conditions in their native villages. This decimation, which continued over more than a century, resulted in such a decline of the native population that African slaves began to be imported to substitute for the disappearing indigenous people as a labor force in the areas where large scale plantations, such as sugar cane plantations, were established. This occurrence was more common near the coast than in the interior of the Basin.

The struggle between church and state over the control of indigenous people's labor and souls took a major turn with the rise to power of Sebastião José de Carvalho e Melo, the 1st Marquis of Pombal and Prime Minister of Portugal, who was a leading European advocate for the separation of church and state and who saw the Jesuits as the main obstacle on the road to this separation (Alden 1969a, 1969b). Pombal fought to suppress the order: first in the Amazon, then in Brazil, then in Portugal. The order was later abolished throughout the Catholic world. This left many previously Jesuit missions in the Amazon in the hands of the state which proceeded to establish directorate villages under the control of civilian directors with the expressed charge to make the indigenous people productive (Anderson, 1999). The poor treatment of villagers led to a greater death toll and to their flight from the villages.

Yet, it is said that from this period of forced living in villages, a hybrid culture developed in the Amazon Basin—a blend of indigenous knowledge of the forest and rivers with European religion, customs, and language. This has come to be called *caboclo*, or *ribereno*, culture (Wagley 1953; Moran 1974). This regional culture was a product of living in isolation, deep in the forest and along river banks, searching and exploiting the products of the forest, living off the rivers and the land—yet connected by Christian beliefs and dependence on a market economy to supply some necessities which persist to this day: sugar, salt, rum, kerosene, hammocks, and other products from the outside. These were obtained by trading products from the forest such as rubber, spices, aromatic barks and

roots, fruits, fish, and game meat. This regional culture found its heyday during the Rubber Boom of the late 19th century when the demand for natural rubber spiked due to the discovery of vulcanization, a process that made natural rubber products more malleable and useful in clothing and in tires for the bicycles and cars that became the rage of the time. Great fortunes were made throughout the Amazon Basin by a few while many people died and were exploited in the search for more wild rubber in the Amazon (Weinstein 1983).

The development in Malasia of rubber plantations based on seedlings taken out of the Amazon resulted in the collapse of rubber prices and, consequently, of the Amazonian economy by the end of the first decade of the 20th century. Rubber production in the Amazon came from trees found in their natural distribution in the forest where there were few individual trees per unit area and where trees required extensive search and extraction on a daily basis. In contrast, Malaysian plantations could produce larger amounts of rubber in small areas of land with a much smaller labor force, thus causing the collapse of the inefficient rubber industry in the Amazon. The region sank into economic stagnation until a very brief period of resurgence during World War II when the Japanese cut off supplies from Malaysia, which increased the demand for rubber from the Amazon by the Allied Powers. Following the end of the War, stagnation set in again. Life continued in the isolated settlements throughout the Basin with modest amounts of rubber extracted and with subsistence economies based on fishing and small scale agriculture (Wagley 1953).

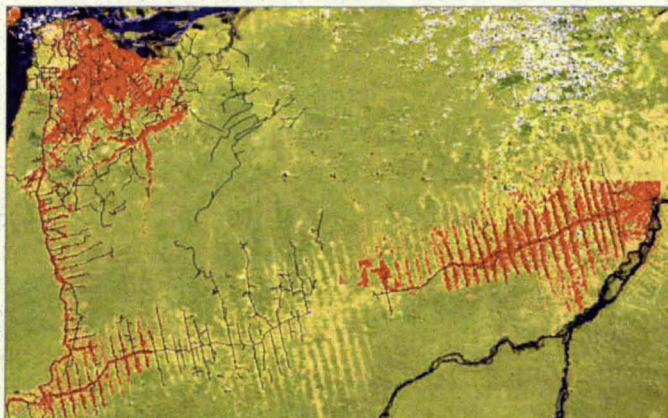
All this began to change in 1970 when the military government in Brazil announced the Program of National Integration and declared that the Amazon region should be part of the national effort to achieve economic development and reach world power status.

II. The Era of Deforestation Begins

The project to integrate and develop the Amazon region of Brazil was carried out at breakneck speed with the new Trans-Amazon Highway, which cut across 3,400 km of rain forest in four years and reached the border of Peru by 1974. As the roads were built, people were brought in by all available means – large jet planes, boats, and buses – to claim land and to begin cultivating it. Incentives were provided to grow essentials like rice, corn, and beans, thereby freeing lands in southern Brazil for the cultivation of soybeans. As part of this development plan, Brazil decided to become the world's leader in soybean production and exports. The growth of soybeans was particularly encouraged with incentives from the government to develop the prime lands in the southern part of Brazil.

Previously stagnant communities along the river revived with the arrival of road crews and the merchants who followed and who provided needed foods and services. At Altamira – one of the sleepy little towns reached by the new highways – the population grew from 1,000 in 1970 to 10,000 in 1972. This sharp increase in population resulted in severe lack of housing for the arriving

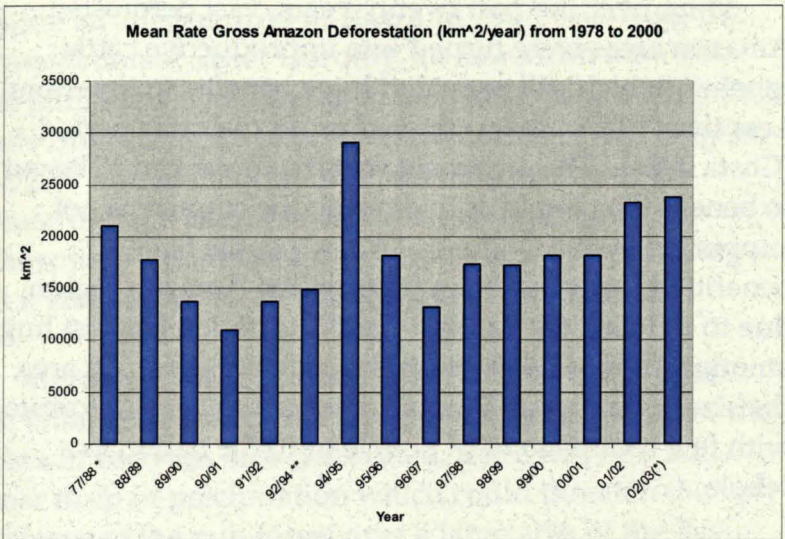
engineers and government personnel and triggered a sharp increase in the cost of food. For example, in 1972 one egg cost one dollar (Moran 1981). I was able to witness this early process of road building and homesteading through a series of research expeditions and projects.



Small scale homesteading settlement scheme showing the fishbone pattern of occupation along the Transamazon highway and deforestation up to 1996

Land was allocated in 240-acre lots. Affordable bank credit was provided to encourage the opening up of the forest as quickly as possible. Government agencies and warehouses provided locations for sales and for repayment of loans. Entrepreneurs came to buy the crops at even better prices. Then, along with the creation of OPEC, the first oil crisis came. Brazil was at that time as dependent on Middle Eastern oil – 80% dependent, to be exact-- as the US was. The rise in oil prices hit hard, leading to reductions in services and stoppage in the construction of the side roads. Life became increasingly challenging but the settlers began to produce and

gradually made the occupied areas productive. The local economies started to take off (Moran 1981).



Source for above figure: Moran 2006:88 based on PRODES/INPE data

During the 1980s and 1990s, the subsidies provided by the government allowed for vast areas of the Amazon region to be cut and turned into grazing pastures for cattle. The subsidies were so favorable that development became all but inevitable. To attract investments, the Amazon Development Agency (SUDAM) offered to match those investments by juridical persons, who were able to deduct from their personal income tax the amounts invested in the Amazon development projects. Any profits were tax-free for ten years so the investors could double the value of their investment by the match, deduct their investment from tax liability, and have no taxes for ten years. Further, any losses from the ranch

could be deducted from tax liability in personal income taxes, removing even the incentive to make a profit.

Thus, over the past twenty years, vast deforested Amazon areas were turned into unproductive cattle ranches (which still provided huge benefits to investors). Less than 10% of them showed profit over this period (Costa 2006). The argument that the forest had to be cut to benefit the people or to develop the country is not supported by the evidence. A few people have benefitted – most of them far from the Amazon region due to reduced tax liability – and the nation has lost huge amounts of income through the tax write-offs. An area the size of Spain and France together has been deforested with few returns to local people or to the nation as a whole.

Deforestation rates during this first period were high because all the credit was used to employ labor and the size of loans was not limited by interest rates. Nearly 20,000 sq km began to be cut per year. This rate has remained steady on a decadal time scale – despite abrupt variations from year to year – resulting in 20% of the Basin deforested as of 2007. It is important to spend some time on this issue because the Amazon is so large and the numbers can be easily misunderstood. Other countries have had a greater percentage of their rain forests cut but in absolute terms, no country in the past thirty years comes close to Brazil. One percent of the Brazilian Amazon is equivalent to Belgium, and 20% is roughly equivalent to the total land occupied by Spain and France together.

Fortunately, 80% of the forest is still left but that's no consolation. The rates of deforestation continue unabated despite an alleged drop in 2006 and 2007, following the assassination of Sister Dorothy, an American nun who was murdered while trying to help local people keep their lands from being invaded by cattle ranchers and loggers. The 20% rate of deforestation not only produces the release of huge amounts of carbon emission into the atmosphere—therefore contributing to global warming—but it also causes incalculable losses in biodiversity.

Moreover, the most recent research by atmospheric and climate scientists in the region suggests that once the Amazon becomes 40% deforested, there will be a non-linear drop in precipitation which could threaten the very existence of the rain forest over a large area of the Basin. The decreased precipitation would become insufficient to support the growth of the rain forest so that the forest would most likely be replaced by savanna-like vegetation, A process that is already occurring on the southern border of the Amazon or cerrado (Nobre et al. 2001). This would not be an unprecedented transformation; it already happened once during the Pleistocene, when much of the Amazon Basin became savanna and the forest was contracted to relatively small refuge areas (Haffer 1969; see figure below). This time, however, the transformation is being accelerated by human-driven deforestation rather than by a long cycle of natural climate changes.

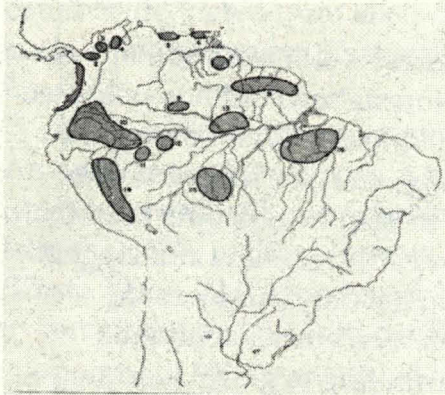


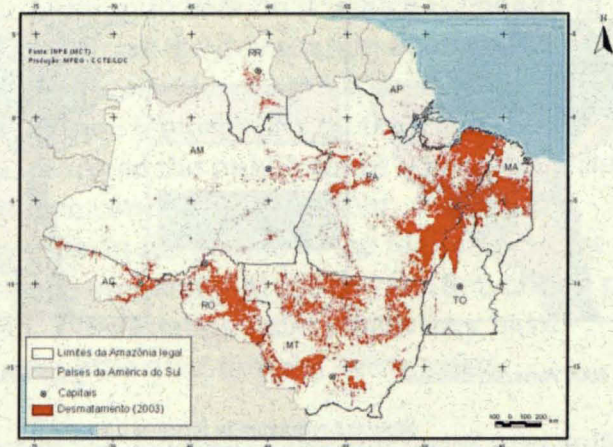
Figure illustrates Pleistocene refuge areas. Dark areas indicate where the tropical rain forest survived, whereas the rest of the Amazon became mostly savannas unable to support tropical forest vegetation and animals (Haffer 1969 and Prance 1982).

A further reason why this scenario is not far-fetched is because of two processes taking place right now: one is the expansion of soybean-growing areas from the cerrado in central Brazil into the Amazon, and the second is the world demand for beef and biofuels.

The Amazon represents the largest area of unoccupied and unexploited cultivable land left on the planet. Brazil has been preparing for this moment since 1970 and accepts no challenge to its sovereignty over the region and to its goal of becoming a member of the club of major industrial nations.

As a matter of national agricultural policy, Brazil has been encouraging the expansion of soybeans [since the late 1960s], first into southern Brazil in the late 1960s and since the mid 1980s, into the cerrado of Brazil. The agronomists in EMBRAPA in Brazil were able to find an agronomic solution to growing soybeans in the acidic, nutrient-poor soils of the cerrado, soils very much like

those in much of the Amazon. Vast areas of Paraná first and Mato Grosso later were transformed into soybean-growing areas. The rate of expansion is staggering, as is the size of the operations. Much of what we hear about Amazonian deforestation is associated with the conversion of the savanna areas, which are considered part of the Amazon even though they are not true rain forest. As much as one third of the Amazon is forested savannas and these were the areas which have seen the most dramatic conversion since the mid 1980s.

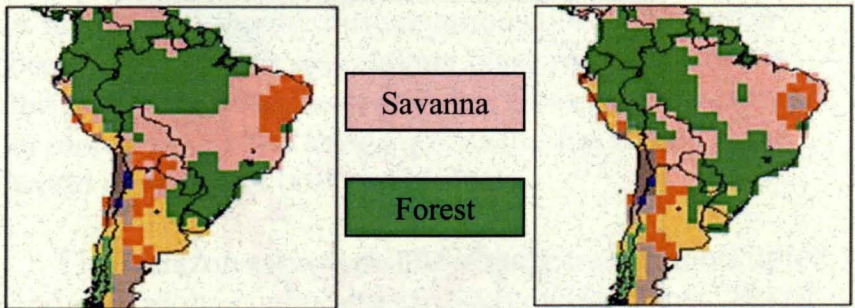


The above figure illustrates cumulative deforestation until 2003. Note the concentration of deforestation along the southern border, called the arc of deforestation.

The soybean producers' ambition to transform Brazilian agriculture knows no bounds and they have kept their eye on expanding into the Amazon. They have succeeded in creating state-of-the-art facilities for handling soybeans at two ports along the Amazon River, one in Santarém and the other at Itacoatiara. As these

facilities were built, eager producers came near these ports and began to buy land in order to transform the Amazon landscape – this time the rain forest proper – into the production of soybeans. At first, when they sought permits to build the facilities, they argued that they would only clear degraded areas that had long been deforested. But in less than two years, reports began to indicate that nearly half of the areas being planted in soybeans had been in fact mature forest regions.

III. Is a Collapse of the Amazon Forest imminent?



2000 Amazon Biomes

2100 Amazon Biomes

Note the reduction in forested area

Despite the dire predictions of climate scientists that suggest Amazon warming of two-to-seven degrees centigrade by the end of the 21st century, sharp drops in precipitation as a result of deforestation, and the stubborn position of the government to deforest and develop agriculture at any cost – just as we have done to achieve economic prowess – there are reasons to believe that the collapse of the Amazon forest can be averted. For one

thing, Brazil is sensitive to world opinion, as long as its critics don't desire to occupy its territory or keep it from developing. Over and over, Brazil has shown signs that it wants the world's leading nations to respect it by responding to environmental efforts to restrain deforestation, protect its remaining indigenous people, and keep its biodiversity. Secondly, unlike the time when the USA cut all its forest—for instance as homesteaders did over most of Indiana—today an army of NGOs and media are present each time a major deforestation event takes place so they can be mobilized to question it and bring public opinion to bear on it, which is enough in some cases to restrain the devastation about to be unleashed. Many areas have been spared from destruction, at least temporarily, by the quickness of NGOs who informed the public about what otherwise might have been concealed from them. Finally, the greatest hope lies in the people of the region, who are growing restless and angry at the devastation taking place around them, a devastation from which they have benefitted very little over the past thirty years.

Evidence of the collapse of the rain forest over several large areas as a result of precipitation drop when deforestation reaches circa 40%—a figure supported by several current regional climate models—comes from the fact that we know that half of all the precipitation in Amazônia is self-generated by the forest vegetation from the evaporation of incoming rainfall into the atmosphere. With deforestation, much of that rainfall no longer evaporates back to the atmosphere. Instead, it runs over

the surface leading steadily to shifts in the local, and eventually regional, moisture balance.

Twenty percent of the forest has disappeared in the past thirty years. While the Gross Domestic Product of Brazil has risen dramatically, the GDP share for the Amazon region and its people has remained stagnant. Even at the aggregate scale of GDP, the people have not benefitted. If we examine its distribution, the dissemination of income has worsened over the past fifteen years rather than improved (Walker et al. in press). This growing inequality in a country already well known for its extreme maldistribution of income can only result in growing social consciousness of the detrimental nature of deforestation. Although at this moment there is no clear sign that the people have spoken in a united voice to stop this destruction of the rain forest that benefits so few, and although the actions of NGOs ultimately cannot stop the market forces driving to supply beef and soybeans for the growing populations of China, Brazil's desire to become a member of the Security Council and of the Club of 8 leading nations may lead to implementing the policies restraining the currently uncontrolled forces that threaten the rain forest's very existence. The value of the forest is bound to increase with its disappearance, as people begin to feel the effects of more global warming, the lack of precipitation, and the loss of the many services that the forest provides – chief among them the moderation of climate in a hyper – humid and warm environment. As the value and beauty of this ecosystem increases, so will public pressure to protect it and to enforce laws that are currently ignored.

References Cited

- Alden, D. 1969a. Black Robes versus White Settlers: The struggle for freedom of the Indians in Colonial Brazil. In: *Attitudes of Colonial Powers towards the American Indians* H. Peckham and C. Gibson (eds.). Salt Lake City: University of Utah Press. Pp. 19-45.
- Alden, D. 1969b. Economic Aspects of the Expulsion of the Jesuits from Brazil. In: *Conflict and Continuity in Brazilian History*. H. Heith and S.F. Edwards (eds.) Charleston: University of South Carolina Press. Pp. 25-71.
- Anderson, R. 1999. *Colonization as Exploitation in the Amazon Rain Forest, 1758-1911*. Gainesville: University of Florida Press.
- Costa, F. de A. 2006. Capoeiras, inovações e tecnologias rurais concorrentes na Amazônia. In: *Inovação e Difusão Tecnológica para Sustentabilidade da Agricultura Familiar na Amazônia*. H.K. Costa (Ed.). Belém: Editora do NAEA. Pp. 21-58.
- Denevan, W. (ed.). 1974. *The Population of the Americas in 1492*. Madison: University of Wisconsin Press.
- Haffer, J. 1969. Speciation in Amazonian forest birds. *Science* 165: 131-137. ??
- Moran, E.F. 1974. The Adaptive System of the Amazonian Caboclo. In: *Man in the Amazon*. C. Wagley (ed.) Gainesville: University of Florida Press. Pp. 136-159.
- Moran, E.F. 1981. *Developing the Amazon*. Bloomington: Indiana University Press.

- Moran, E.F. 1993. *Through Amazonian Eyes: The Human Ecology of Amazonian Populations*. Iowa City: University of Iowa Press.
- Moran, E.F. 2006. *People and Nature: An Introduction to Human Ecological Relations*. Oxford: Blackwell.
- Nobre, C., P. Artaxo, M. Assunção, E. Dias, R. Victoria, A. Nobre, and T. Krug. 2002. The Amazon Basin and land-cover change: A future in the balance? In: *Global Change - The IGBP Series: Challenges of a Changing Earth*. W. Steffen, J. Jager, D. Carson, and C. Bradshaw (eds.). Springer Verlag, New York, pp. 137-141.
- Prance, G.T. 1982. Forest Refuges: Evidence from woody angiosperms. In: *Biological Diversification of the Tropics*. G.T. Prance (eds.) New York: Columbia University. Pp. 137-158.
- Roosevelt, A., R. Housley, I. Imazio da Silveira, S. Maranca, and R. Johnson. 1991. Eighth Millennium Pottery from a Prehistoric Shell Midden in the Brazilian Amazon. *Science* 254(5038): 1621-1624.
- Wagley, C. 1953. *Amazon Town*. New York: Macmillan.
- Walker, R. et al. In press. A Economia Amazônica hoje e amanhã: integração nacional e o crescimento da produção. In: *Ambiente e Sociedade na Amazônia*. D. Alves, M. Batistella and E.F. Moran (eds.). São Paulo: EDUSP.
- Weinstein, B. 1983. *The Amazonian Rubber Boom, 1850-1920*. Stanford: Stanford U Press.

