
Soybeans, Development and Conservation on the Amazon Frontier

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ABSTRACT

Bolivia's rate of deforestation throughout the 1990s was among the most rapid anywhere in the Amazon Basin. This drastic clearing stood in sharp contrast to the relatively slow rates of landscape change that had prevailed in previous decades. This article reviews the models used for explaining deforestation, and argues that the new context of globalization, structural adjustment, regional integration and rapid technological change contributed to accelerated forest cutting during the 1990s. The author suggests that many environmental policy approaches developed during the 1970s and 1980s no longer address the current clearing situation effectively, and that today's frontiers differ profoundly from previous ones. The widely held idea that intensive production *per se* reduces forest destruction may not be valid on tropical agro-industrial frontiers, such as the soybean zones of Bolivia and Brazil.

INTRODUCTION

Deforestation continues to be widespread and dramatic throughout the Latin American tropics. Concern over the impacts of this enormous ecological transformation on climate, biodiversity and local societies has produced literatures devoted to explaining forest clearing, elaborating policy alternatives and exploring interventions to slow the processes of forest loss. This article argues that recent large-scale socioeconomic changes, including structural adjustment, economic globalization and new technologies, have stimulated deforestation, and that many of the current conservation policy 'solutions' developed in earlier periods to curb clearing may well encourage, rather than slow deforestation. This is especially the case in less glamorous forest ecosystems such as tropical savannas and semi-deciduous woodlands — ecosystems that are especially under threat from industrial agriculture, with little conservation infrastructure.

Unlike many other areas of the Amazon where large-scale economic expansion was based on extraction of minerals and timber (like Ecuador and parts of Brazil), or the rentier ranchlands and speculative fronts of parts of the Brazilian Amazon, the current economy of Bolivia's tropical hinterlands has been characterized by a productive, high value, agro-industrial

frontier with tremendous capacity for converting large areas of forest. The explosion of this intensive, productive and profitable land use, coupled with shifts in the macroeconomic context, call into question many of the policy recommendations advanced through the 1970–90s to slow deforestation.

The Bolivian lowland frontier differs in many respects from others in Amazonia. Its resource endowment, historically unusual property regimes,¹ political history and depth of labour and native social organization place it apart from most other Amazon development fronts. Bolivia's Amazon is home to a powerful modernizing elite based in the city of Santa Cruz who developed the most economically dynamic agricultural sectors in Bolivia's national economy. Table 1 provides an indication of the importance of the Department of Santa Cruz in national agriculture. In Bolivia, five crops (rice, maize, wheat, sunflower and soy) accounted for almost 68 per cent of the 1,884,240 hectares in food production of all types in 2000. The Department of Santa Cruz accounted for more than two thirds of these crops. While soy, sunflower and wheat developed mainly with mechanized double cropping technologies in the region, over 80 per cent of the classic 'peasant crops' of corn and rice are produced with mechanized production and modern inputs in Santa Cruz (CAO, 2002). This agro-industrial model has not been characterized by production sustainability, however, but has been volatile for financial, policy, market and environmental reasons (Barber et al., 1996; Gill, 1988; Kaimowitz et al. 1999; Pacheco, 1999; Thiele, 1995).

This article proceeds by outlining the dynamics of deforestation in the Bolivian Amazon. It then assesses how well the models usually invoked to explain deforestation (and the policies derived from them) actually work in the new economic contexts that developers and conservationists now face — the neoliberal frontier — and suggests some of the policy approaches and

Table 1. Area of Major Crops in Santa Cruz compared with Bolivian Totals (1000 ha)

Crop	Santa Cruz	Bolivia total	SC as % of total
Rice	104	156.3	66.5
Maize	104	277.2	37.5
Wheat	52	119.5	43.6
Sunflower	130	130	100
Soy ^a	490	616	79
Total	880	1300	67.6

Note: ^aThe remaining soy is produced in adjacent departments but still in Bolivian lowlands. Virtually all soy is an Amazon product. Rice and wheat follow a similar pattern.

Source: CAO (2002)

1. Until 1994, the state retained all land rights from subsurface to agricultural, timber and extractive rights, and leased these to producers.

research issues that merit further review. Based on research in both Bolivia and Brazil, the article argues that the new milieu at this neoliberal frontier is qualitatively different from earlier periods, representing a substantive shift in forms of production, economic organization and development ideologies. The logics of land occupation have shifted, and the means of achieving conservation must now also change.

BOLIVIA: THE ENVIRONMENT OF THE SANTA CRUZ 'EXPANSION' ZONE'

Deforestation of Bolivian tropical forests proceeded at an accelerating rate from the late 1980s, with annual clearing of 123,000 ha per year by the late 1990s (Steininger et al., 2001). While annual clearing rates declined somewhat after 1998 due to the profound economic crises that occurred as an outcome of the Asian economic shocks, national political instability, difficulties in the Brazilian economy, and increasing insecurity in Colombia (Bolivia's main soybean buyer), the expansion of the agricultural frontier means that Bolivia remains a 'deforestation hot spot', to use Pacheco's (2003) term. More than 2 million ha of Bolivian lowland forests have now been cut. Most of this deforestation concentrates in an area to the east of the Rio Grande River, bounded to the south by the railroad line to Puerto Soares, and to the east by the Brazilian Shield areas of the Chiquitania. Known as the 'Expansion Zone', it is the area that was under the aegis of the World Bank's *Tierras Bajas* Project from 1990 to 1995 (Baudoin et al., 1995).

Forest clearing in Bolivia is overwhelmingly concentrated in the tropical semi-deciduous forests which have been almost entirely eliminated elsewhere in South America. Indeed, some tropical ecologists (Janzen, 1988; Mooney et al., 1994) and conservation agencies such as World Wildlife Fund and Conservation International have placed Bolivian Amazon forests at the top of their global priority lists because of their imperiled status (Conservation International, 1993; Dinerstein et al., 1995; Parker et al., 1993). Loss of critical areas of endemic biodiversity and the definitive conversion of forests and their economies have ravaged what was once one of the largest forest formations in Latin America. Bolivian forests are especially significant because they embrace Andean, Amazonian and Chaco biotic elements, and include important (and threatened) centres of diversity for crop plants like peanuts, runner beans and tomatoes. While international attention has focused on the high biomass selva, the erosion of biodiversity and effects on greenhouse emissions associated with the comprehensive destruction of the semi-deciduous forests may be more significant in the medium term, because of the vast areas involved and the quantity of below-ground carbon stored in these ecosystems (Abadala et al., 1998). These forests, though of immense ecological value, are of lower biomass (20–100 mt/ha) as compared with the

200–600 mt/ha of some high areas of more humid forests to the north, in the departments of Beni and Pando (see Killeen et al., 1998; Parker et al., 1993; Steininger et al., 2001). The result is that these lowland forests are easily, and relatively cheaply, cleared with heavy machinery, and are currently undergoing extremely rapid conversion into industrial grain agriculture.

The Bolivian Amazon in the Department of Santa Cruz has some of the highest quality upland soils in all of Amazonia. The soils occur in largely flat landscapes, and when there is relief, it is quite modest — usually less than 5 per cent. The regional climate helps maintain the chemical fertility of the soils because the sharp dry season results in phreatic dislocation of bases from the lower parts to the upper parts of the profile: essentially they are ‘self-fertilizing’. On the basis of their soil chemistry alone these soils represent an extraordinary land resource, and in light of the poor quality of most Amazonian soils, Bolivia’s lowland soils appear to have the highest potential for sustainable agriculture in the Basin. According to the agroecological zoning map for the Department of Santa Cruz, 4.4 million ha of the Bolivian lowlands — an area equal to the entire Amazon floodplain — is suitable for intensive agriculture (PLUS, 1996).

The favourable chemical composition of these soils belies their vulnerability to physical degradation. The problem of compaction is exacerbated by the system of continuous double cropping. Heavy machinery moves on these soils in both the dry and wet seasons. The seriousness of these processes of degradation is easily overlooked and a ‘sustainability crisis’ has already occurred in some of the oldest soy areas developed by Mennonites in the early and mid-1980s, to the northeast of Santa Cruz (Barber et al., 1996). As erosion and compaction proceed, these areas have shifted into cattle production. While the use of minimum-till technologies has begun to spread, and attempts at creating more sustainable multi-cropping practices are the focus of a great deal of agronomic research, the herbicides and nematode build-up associated with such practices contribute to the potential agroecological instability of the industrial agricultural landscape (Baudoin et al., 1995; Bojanic, 1997).

EXPLAINING DEFORESTATION

The development zones in the Department of Santa Cruz, where most forest clearing is concentrated, have seen very dramatic rates of deforestation. Clearing in this region jumped from less than 20,000 ha per year in the early 1990s to more than 100,000 ha per year by 1998. While there has been a slight contraction due to the severe Bolivian economic crises, rates of clearing remain high overall, and especially compared with previous decades.

How well do the main models for explaining deforestation work in the Bolivian case? And how well do the policies derived from them address the questions of forest conservation in this new economic frontier? What in the

end drives this clearing and what are the most sensible policy options in this region? This section outlines how Malthusian approaches, property rights perspectives, and various economic models, which are usually invoked to explain deforestation, perform in the contexts we now observe in Bolivia.

Malthusian Models

The Malthusian model is still the most prominent approach for explaining deforestation. This framework suggests that increasing population directly produces greater deforestation as incoming migrants clear forests for agriculture. Although Malthusianism has been critiqued extensively and for decades, it still holds sway in the policy literatures of tropical development (cf. World Bank, 1993), agricultural development (Greenland et al., 1998) and conservation (cf. Terborgh, 1999). Recent empirical studies suggest that simple population correlates have weak or ambiguous effects on deforestation (Gibson et al., 2000). In Amazonia the value of Malthusian models for explaining regional clearing patterns has been questioned for decades (Alston et al., 2000; Hecht, 1985; Kaimowitz and Angelsen, 1998; Perz, 2002). Indeed, the Brazilian Amazon has seen a net decline in rural population (most of its inhabitants are urban), yet the region underwent dramatic clearing throughout the last decade. In Bolivia's Amazon, most migration was either to the coca regions of the Yungas or to the main urban centres such as Santa Cruz, and thus did not involve lowland deforestation (Pacheco, 1999, 2002; Urioste, 2001). Current remote sensing information reveals a pattern at odds with this traditional explanation and shows clearly that population increases are not the central drivers for deforestation in lowland forests (Steininger et al., 2001). In fact, recent data on ownership from the three largest banks holding mortgages in the region indicate that some 800,000 ha is farmed by just 175–250 persons or corporate entities (Zoomers, 2003).

The Social Structure of Clearing

While Bolivia has had colonization programmes for its 'Oriente' since 1905, and pursued aggressive colonization policies from the 1950s to the late 1970s, the patterns of occupation have not generated the kinds of explosive deforestation visible in places like Rondonia, nor volatile patterns of out-migration.² There is, however, a clear distinction in the characteristics and spatial location of clearing between large- and small-holders on the Bolivian

2. Comparing surveys from 1990 and 1999 shows that in colonization areas, some 73 per cent of the initial survey population was still in place, a very different situation to that prevailing in Rondonia.

Frontier in the expansion zone of the Department of Santa Cruz: large holdings expand in the form of very large rectangles in swaths moving to the east of the Rio Grande, while small-scale holdings expand in irregular plots in designated colonization zones or in the familiar 'piano key' clearing along the roads largely to the north of Santa Cruz. The implications of this clearing pattern can be broken down into clearing classes and analysed over time.

The clearing impact of smallholders and large-scale owners was initially comparable, and relatively slow by many Amazonian standards prior to the soybean boom, during the 1970s and 1980s. After 1985, however, with structural adjustment, the emergence of the Expansion Zone as a development focus, changes in the agrarian legislation, and technical changes in agriculture, agro-industrial farming led to explosive clearing, producing an exponential deforestation pattern (Vilar and Kupfer, 1995). In contrast, clearing by small farmers increased in a linear way.

The data in Table 2 show that more than 1,839,000 ha were cleared by large and small land owners from 1986 to 1998. Mennonite farmers — immigrants from Mexico, Belize, Brazil and Canada — were the first to introduce commercial soy production. While their domestic lives are based on traditional technologies, such as horse-drawn carts, their agricultural systems are highly mechanized, high-input systems, and comparable to the techniques used by industrial producers. Peasant and colonist producers often used traditional slash and burn, and partially mechanized systems. At the beginning of the structural adjustment period (1986), small-scale producers (some 8,000 households) generated almost 24 per cent of the annual clearing. Slightly more than a decade later, peasant clearing was responsible for about 10 per cent of annual deforestation. In the entire 1986–98 period, slightly more than 12 per cent of the lost forest was the result of peasant production, and of the areas they had cleared, roughly half were in secondary forest, as part of their land management practices and as subsidies to household livelihoods. These areas created complex mosaics of old growth, successional forests and agriculture, a type of landscape that can support significant biodiversity (Pena-Claros, 2003). The actual number of corporate and Mennonite producers is not known; their active numbers in

Table 2. Annual Clearing (in ha) by Type of Agriculture in Santa Cruz Expansion Zone, 1986–98 (determined by remote sensing)

	1986	1988	1990	1992	1994	1996	1998
Peasant Agriculture	9,282	11,095	16,184	17,772	23,120	21,419	31,566
Colonist	6,956	11,573	14,424	13,669	23,717	22,824	11,791
Mennonite	22,501	24,649	52,060	89,954	147,914	223,965	188,485
Industrial	29,457	36,222	66,484	103,623	171,631	246,789	200,276
Total Agriculture	68,196	83,539	149,152	225,018	366,382	514,997	432,118

Source: Steinger et al. (2001).

the 'clearing hot spot zone' were estimated at less than 2,000 by a World Bank evaluation team (Baudoin et al., 1995), but recent surveys of the land markets suggest that the numbers are far lower (Zoomers, 2003).

Table 3 provides information about crop expansion since 1986, the beginning of the structural adjustment period. Soy increased its area by a factor of more than six up to 1998; mechanized wheat increased by more than a factor of ten; and corn, which is used as a rotation crop with soy as well as a human and animal food, doubled its area. Other rotation crops such as sunflower (which was hardly grown in the region in 1990) increased from 10,000 ha in 1990 to 110,000 ha by 2000. Sorghum, also grown in rotation, quadrupled its area, while the quintessential peasant crop, rice, showed some dynamic growth in the middle 1990s, but its area actually contracted as cheap food import policies competed with local production. Clearly the dynamics of deforestation are not being driven by demographics and peasant agriculture. Industrial production of soy, wheat, sorghum with rotations of sunflower show by far the most dramatic increases.

The performance of wheat is unusual, and thus requires some further analysis. The expansion of wheat was part of USAID's PL 480 programme which supplied food aid to this region in the form of grain, and worked with industrializing Mennonite communities who had had experience in mechanized wheat production in Canada, Paraguay and parts of Mexico. Soy had traditionally been grown in rotation with wheat in southern Brazil. As Mennonite communities moved further to the east of the expansion zone, the sustainability and limits of wheat (due to climatic and soil features) as well as credit contraction worked against the crop. By 2000 its acreage had declined by some 80 per cent in the expansion zone, and 65 per cent elsewhere in the Department of Santa Cruz.

Table 4 reveals another trend. If we examine the changes in crop areas over the 1998–2000 period as opposed to the period of 1986–2000, when the boom began, a picture of sharp contraction emerges. These declines reflect the crisis in the Bolivian economy as well as in the grain purchasing

Table 3. Crop Area 1986–2000 (1,000 ha) in Santa Cruz Expansion Zone

Crop	1986	1988	1990	1992	1994	1995	1996	1998	1999	2000	Change 1986–2000
Cotton	11.2	10.0	3.9	26.3	18.0	24.5	52.0	50.0	35.0	4.5	–6.7
Corn	17.1	14.2	19.7	35.4	22.5	32.8	34.0	15.5	33.5	19.0	+8.9
Rice	13.7	16.2	18.2	18.2	24.1	21.9	10.0	10.0	8.0	7.0	–6.7
Soy	68.2	85.4	179.3	200.2	340.4	402.3	278	372	377.5	346.0	+277.8
Sorghum	12.1	20.0	30.0	25.2	35.0	55.0	30.5	71.3	37.8	49.7	+37.6
Wheat	10.0	4.0	30.0	63.9	53.5	68.6	108.5	88.5	35.8	22.6	+12.6
Sunflower	–	–	10.7	20.1	60	41	36	131	96.0	111.0	+100.3
Total	132.3	149.8	291.8	384.3	563	539	623	742.9	623.4	580.3	+448

Source: CAO (1987–2001)

Table 4. Change in Crop Area 1998–2000

Crop	Change 1998–2000	
	%	Area (1,000 ha)
Cotton	–81	–45.0
Corn	+26	+3.5
Rice	–30	–3.0
Soy	–7	–26.0
Sorghum	–31	–21.6
Wheat	–75	–65.9
Sunflower	–16	–20.0

Source: CAO (1999–2002)

economies of Colombia and Brazil. They also reflect climatic problems. The least dramatic changes in production area occurred in the rice and corn sectors, which are overwhelmingly in the hands of small farmers.³ In the 1998–2000 period, more than 162,000 ha went out of production, slightly more than one fifth of the total acreage. This pattern gives some suggestion of the extreme volatility of these kinds of frontiers and their flexibility in response to prices.

Property Regimes: Land and Land Law in Santa Cruz

The role of property regimes in deforestation has long been a subject of debate. While the analytic and critical arena has expanded substantially (cf. Alston et al., 2000; Bromley and Cernea, 1989; Gibson et al., 2000; de Janvry et al., 2001; Ostrom, 1991, 2001), in practice, structural adjustment programmes and institutional development projects regularly seek to normalize land markets within the framework of private property regimes. These efforts have focused on the conversion of customary tenure to freeholdings, privatization of public lands, and the legalization or formalization of illegal forms of occupation. In the structural adjustment literature, more efficient, environmentally-sensitive land uses are expected to result from the emergence of private property regimes, as land markets are thought to reward intensive investment and most rational, ‘highest’ uses, and to internalize production externalities. In this view, private ownership assures that farmers capture the benefits of their investments and assumes that intensive land uses do not degrade ecosystems.

The idea that faulty property regimes drive deforestation is informed by three main bodies of thought: the theoretical literature on common

3. In Santa Cruz, large producers (100–2,000 ha) account for only 311 of the 18,271 rice producers, while only 87 of the 13,374 corn producers cultivate more than 50 ha.

property and externalities (see Hardin, 1968); the structuralist literature on agrarian reform which argued that highly unequal land distribution and insecurity of tenure inhibited investment, leading to land-degrading uses and a moving frontier; and the recent institutional literature on tenurial regimes and deforestation (Alston et al., 2000; Gibson et al., 2000).

Hardin's 'tragedy of the commons' has maintained a remarkable hold on debates about forms of tenure, and is part of the intellectual pedigree of current privatization pressures. Hardin himself emphasized the externalities associated with land degradation under open access regimes, rather than the investment/management arguments that were later more broadly applied using this paradigm (see Ostrom, 1991). The analysis of property regimes and resource use throughout the world has called into question the simplistic condemnation of common property regimes (see, for example, Beaumont and Walker, 1996; Gibson et al., 2000; Ostrom 1991, 2001). Others, such as Kaimowitz (1997) have suggested that non-private forms of land tenure can sharply reduce clearing, a position also supported by data on clearing from areas such as Acre in Brazil, with its extensive extractive and indigenous reserves discussed in Gibson et al., 2000).

The earlier latifundia/minifundia and sharecropping literature that focused mainly on peasant productivity argued that tenurial insecurity limited investment and undermined resource management. As this tenurial model was applied to frontiers, it suggested a 'hollow frontier' where a peasant front of minifundias with insecure tenure moved ever forward as land holding consolidated in larger holdings behind them. In this structuralist literature, secure holdings would stimulate peasant investment and slow frontier expansion and deforestation. In more recent incarnations, as the agrarian reform debate expanded into deforestation controversies, clearing has become a means of asserting tenure in areas of conflicting rights, by reducing probability of state expropriation or squatting by showing 'effective' use. It overrides claims to other above-ground resources such as timber or extractive products (cf. Alston et al., 2000; Hecht, 1993; Kaimowitz and Angelsen, 1998; Schmink and Wood, 1992). Alston's model showed how large- and smallholders have incentives to clear prior to land conflict, and that clearing reduces the likelihood of conflicts. How do these bodies of theory play out in the Bolivian case?

Land Rights in Bolivia

Land rights in the Bolivian Amazon typically include indigenous claims, colonial holdings, early colonist projects of the late nineteenth and early twentieth centuries, resource extraction claims including mineral, non-timber forest products, timber, grazing rights, and more modern forms of tenure including land settlement allocations for small-scale farmers, colonist and political resettlement, and private land rights. Several different kinds of legal and fraudulent claim can exist on a given piece of

land, due to administrative weaknesses in land agencies, regional and federal land allocations that overlap, illegal land transfers, transformation of extraction concessions into private property, technical survey deficiencies, and land frauds of diverse types. This situation is by no means unusual in Amazonia (see Hecht and Cockburn, 1989; Schmink and Wood, 1992).

However, Bolivian property rights are distinctive compared with most other Amazonian countries as a consequence of the 1952 Revolution and its Agrarian Reform. Until 1996, and the new Agrarian Reform Law, the State retained all rights to land and its resources and basically 'leased' rights to users. Thus, a piece of land could have overlapping mineral, agricultural, timber and usufruct concessions granted by different agencies to different users. This made for some sharp conflicts about competing uses, but it has served as an important brake on the kind of clearing seen more widely in the Brazilian Amazon, where deforestation expands in order to capture ancillary benefits such as timber and minerals (Hecht, 1993). Further, since rural land under the old law could not be used as collateral by financial agencies in Bolivia (because it was feared that peasants would become indebted and thus lose their lands) the ability to use it as a vehicle for various kinds of institutional rents — as occurred in the Brazilian Amazon — was sharply curtailed.

Historically the State has protected the property claims of small farmers, those in community tenure, and individual holdings within communities. Peasants could thus capture gains from their investments in spite of the lack of 'ground' ownership. But a *de facto* form of private property evolved in the most active soybean areas prior to the 'reform of agrarian reform' and has been institutionalized in the Agrarian Reform Law of 1996.

Bolivia's land titling process has been extremely cumbersome, involving in excess of fifty steps through the various titling agencies. To avoid the endless delays, two central strategies have emerged. The first is simply to recognize *de facto* land rights in the commercialization of improvements and use in what are called *derechos reales* or 'actual rights'. These rights to improvements can be bought and sold and function effectively like title. Direct occupation and notarized registry of *derechos reales* became one means of semi-legal land claim and created a type of land-related market. The second method — invoking the traditional cry of agrarian reform throughout Latin America, 'Lands to those who work it' — involves direct clearing for claiming or at the very minimum, clearing the perimeter of one's claim. In the transition period (1993–96) when vast areas shifted from State to private ownership, deforestation accelerated at all scales of production to legitimate traditional and new claims to land. In this process, a novel twist on agrarian ideology occurred.

Land to Those Who Work It

In Santa Cruz, more than 40 per cent of titles overlap, reflecting the problems of double jurisdiction by the separate land agencies, previous

titling practices, and spontaneous colonization (Hecht, 1995). Land contest in Bolivia is generally adjudicated on the antiquity of title, but the ultimate arbiter of claims resides in the radical slogan *La tierra a quien la trabaja* — land to those who work it. This populist slogan, initially raised against absentee landowners, has now a much distorted meaning in the Bolivian lowlands where most claims lacked the documentation necessary for full legal registration. With agricultural mechanization, those who own tractors can vastly outclear and cultivate those who work by hand. ‘Land to those who work it’ has now been appropriated by the agro-industrial elite as a central justification for their large holdings and has contributed to a large-scale transfer of holdings from public or collective domain into private hands.

The 1996 Agrarian Reform Law ratified private land markets for commercial holdings, unified resource rights (except for subsurface rights), and facilitated land transactions. The land use approach insisted on a highly commercial model of development, a policy element specifically developed by negotiators from Santa Cruz and justified as a means of stimulating agricultural modernization.

Areas of *de facto* and now real private property regimes in the lowlands of Bolivia — the commercial agriculture zones of Santa Cruz — are those with the highest rates of deforestation in the Bolivian frontier, and among the highest in all the Amazon Basin. Peasant holdings, which are inalienable, and often under at least partial communal tenure do not show such dramatic clearing rates. While a large literature has hailed private property rights as a means of curtailing deforestation, in Bolivia the transition to private property regimes and the ratification of ‘effective use’ stimulated a ‘Claiming and Clearing’ frenzy that was also fuelled by commodity markets in the Expansion Zone.

Pasture and Property Regimes

The shift from *derechos reales* and concessions has also had another effect on deforestation. In the main forestry areas of Santa Cruz near the Bolivian border in the municipality of Chiquitania, a new, fairly remote deforestation front associated with a shift to pasture is occurring, and accounts for some 30 per cent of the total deforestation in the department (Camacho et al., 2001). Merry et al. (2002) argue that the shift from forest concession to private holdings and the low stumpage value of these woods has provided an incentive for ranching. Since the timber is not particularly valuable, returns to log sales from land are applied to pasture development — seen as more lucrative than forest management — on these new private holdings. As concessions, such areas were obliged to remain in forest. As private holdings, they now shift to pasture.

Land Markets and Clearing

In one of the few recent studies of Amazonian land markets, Zoomers (2003) makes several cogent points. First, markets are quite segmented

among peri-urban small speculators, peasant farms, medium-size urban professional 'recreational' rural owners, and large estates, with little overlap among the various actors and virtually no sales between them. Each follows a different logic. The ensemble of these actors placed 1,154,343 ha for sale in formal land markets during 1998–99, of which 800,000 ha (almost two-thirds of the area for sale) were offered as large farms. Between 1990 and 1999, prices for agricultural land almost tripled with the average price for large-scale mechanizable agricultural land at about US\$ 960 per ha. Clearing added about US\$ 500 of value per hectare in large estates by the end of 1999. Cleared pasture near roads could sell for about US\$ 500 per ha (Merry et al., 2002). For large holders there were two incentives for deforestation: it produced clearer titling rights, and cleared land was worth more. Many large owners, and about half the peasant owners, received their lands at virtually no cost.⁴

The informal land market for smallholders in colonization zones was relatively stable, with 'improvements' adding about US\$ 165 per ha to the selling price, and purchasers generally being known to the seller. Zoomers suggests that these sales are not distress sales but rather a means of eliminating less desirable land or of generating capital for another activity. Out-migration and land concentration, features often associated with Amazon frontiers, were not really an outcome of these land transactions, since populations, number of owned lots and the area under cultivation remained relatively constant over the decade 1990–99 (Zoomers, 2003). The 'hollow' and consolidating frontier phenomenon was not especially salient, in part because of the current geographic separation between colonization and industrial agricultural zones (Thiele, 1995).

While many land holdings were on offer, there were actually few buyers. Of the 1500 large estates for sale during 1996–99, only forty-five sold, while smallholders were able to actually transact only about 10 per cent of the properties on the market. The questionable profitability of agriculture in this period is further expressed in the finding that some 175–250 enterprises, farming about 800,000 ha, were facing foreclosure from banks (Zoomers, 2003). The implications of this type of fiscal instability suggest possible abandonment of parcels, or their conversion to pasture.

The implementation of the new Agrarian Reform Law privatized land and 'rationalized' land markets, generating economic dynamism though of a quite volatile type, as the cropping retraction suggests. In general, it seems to have stimulated rather than slowed deforestation.

4. In the main peasant producer area to the north of Santa Cruz, Zoomers (2003) reports that about half the owners had purchased land. Pacheco (2003) and Baudoin et al. (1995) note that many of the land concessions in the expansion zone had been passed on for political favours.

Economic Models of Resource Use and Degradation

During the 1980s economic analyses were increasingly applied to tropical forest areas in order to better understand the regional dynamics and to improve tropical development policy. The approaches used mostly fell into two large camps. The first, more focused on political economy and macro-economics, emphasized broader structural features and policies associated with growth pole models of regional development. The second method was more micro-economic in its thrust and emphasized valuation, segmented markets and better factor allocation as key elements for slowing deforestation.

Speculative and Rentier Frontiers

One of the most important research terrains in deforestation has centred on the analysis of the role of speculation and institutional rents in driving destructive land uses. These approaches emphasized the role of infrastructure, fiscal incentives and credit policies, as well as a broader array of subsidies in driving land speculation (Binswanger, 1989; Hecht, 1985, 1993; Repetto and Gillis, 1988). Meant to attract capital to the area, and informed by growth pole development planning mediated by regional planning agencies such as Sudam (in the Brazilian case) and Cordecruz in Bolivia, these agencies helped foster a situation in which land itself became a medium for capturing economic rents (see Hecht, 1993; Hecht et al., 1988; Mattos and Uhl, 1993). In addition, booms in mahogany, gold and other minerals also contributed to a spiralling rise in land values. In a situation of highly questionable titling, both large-scale corporate occupiers and small-scale farmers resolved ownership questions through violence, widespread clearing and development of pasture.

While some speculative processes associated with roads are emerging, the overall impact and scale of infrastructure development has been relatively mild in Bolivia, compared with the explosive clearing of the 1970s in Brazil (Mertens et al., 2004). Moreover, road building has not expanded extensively into new soy areas, but has focused on improving existing infrastructure, especially the Cochabamba–Santa Cruz highway. The World Bank's Tierra Bajas project, often and in this case wrongly held responsible for the Bolivian soybean boom, built less than 50 km of roads (Baudoin et al., 1995).

Subsidized credit lines were a significant feature in the clearing dynamic of the Brazilian Amazon in the 1970s and 1980s, but the Bolivian case is quite different. In earlier Bolivian land law, rural land could not be used as collateral for loans. To acquire funds, producers could mortgage urban properties, or borrow operating capital from equipment salesmen, commercial houses, affines and other sources of informal credit. This situation tended to favour entrepreneurial borrowers with urban properties and, for peasants, usurious lenders, and ultimately led to the development of an

elaborate informal or secondary credit market that operated outside the banking system. More recent credit availability in Bolivia has been conditioned by the Agrarian Reform Law, the provisos of structural adjustment packages, and bureaucratic roadblocks. On the whole, the pattern of clearing has not been strongly driven by the *formal* credit markets.

The requirements of structural adjustment policies meant that whatever credit was available was expensive, stipulating high indices and discount rates which pushed agricultural interest rates to the 18 per cent range, largely untenable for many production activities. The interest rates of multi-lateral lenders were higher than those of commercial banks, and had several limits on them. The World Bank, for example, hoped to use the credit mechanism to discipline patterns of deforestation; it would not provide credit for clearing, and had substantial bureaucratic hurdles that resulted in a dilatory interest in its credit lines. Thus, of World Bank funds available for credit in the Bolivian lowlands, only US\$ 10 million out of a package of US\$ 26 million was actually lent.

There were, however, other important sources of liquidity in the 1990s: according to ANAPO (the soybean producers association), the coca industry (which in Bolivia garnered between US\$ 600 and US\$ 800 million per year during the 1990s; see Steiner, 1998), the semi-legal timber industries, and gas development, all provided capital that found its way into the agro-industrial system. Mennonites, Japanese and Brazilian growers all had access to credits other than those provided by Bolivian banks.

The Micro Economics of Conservation

As large-scale interventionist state policy waned in the 1980s, and the neoliberal ideological climate increasingly held sway in development circles, conservation policy-makers increasingly sought to use market mechanisms to promote conservation goals. The thrust of these efforts in ecological economics focused on: (1) 'getting the prices right' — the larger question of the valuation of tropical resources; (2) the development of segmented or 'green' markets whose consumers would be willing to pay premium prices; and (3) addressing the constraint of capital scarcity which was assumed to limit the adoption of intensive technologies.

The 'valuation' arguments asserted that if markets reflected the true value of tropical forests, their cumulative worth would exceed the value of their land uses. Markets would allocate efficiently and forests would stand. A minor industry in valuation exercises soon emerged (see Costanza et al., 1997; Daily et al., 2002; Peters et al., 1991, among many others). Methodologically, there were many analytic problems with these studies, but usually the point of comparison was the total value of non-timber forest products compared with peasant agriculture and livestock. The worth of a standing forest thus exceeds returns to a relatively low value peasant system, or

relatively unproductive pasture, especially when ecosystem services such as carbon sequestration are included (Balmford et al., 2002; Fearnside, 1997; Kremen et al., 2000). The problem in the Bolivian case was that the valuable timber in the Santa Cruz development frontier was removed decades ago, the non-timber forest products are minor and scattered, and the replacement land uses are currently exceptionally valuable. There are over 100 forest products that are collected in the Bolivian Amazon but they have extremely limited or informal markets and have little presence in the statistics collected by the Camera Agropecuario (Agricultural Chamber of Commerce). Many important products, such as Brazil nuts, are collected and processed in different departments, and thus do not appear in the Santa Cruz statistics. As Table 5 suggests, the numbers are chastening. The value in the NTFP comes almost exclusively from Palmito, which is currently not harvested sustainably.

Without 'oligarchic' forests (relatively homogeneous stands), the potential returns from Bolivia's non-timber forest sector in its semi-deciduous forest region are very low on a per hectare basis (US\$ 2–4 per hectare), a finding echoed in other reviews of the value of NTFPs (Anderson et al., 2002). Forest conservation based on the economics of non-timber forests is not very likely in this scenario. The oft-repeated nostrum that better market signals for forest products would effectively curb forest destruction has validity in some cases, but it doesn't hold up well under the forest and agricultural configuration in Santa Cruz. It is the value of industrial agriculture that, unsurprisingly, pressed the deforestation frontier forward.

A central thrust of many conservation and development efforts resided in the elaboration of 'green' international markets (Clay, 1988; Freese, 1998) which blended the joint pleasures of virtue and consumption. By emphasizing, and creating enhanced value for, local forest or peasant products and targeting them to high-end consumers, green activities could obtain premium prices for their goods. Organic coffee production has been quite successfully promoted for the Chiquitano Indians of Velasco, near the Brazilian border, and more montane Amazon cacao producers have also used green markets (Bebbington, 1996).

Table 5. Value of Industrial Crops compared with Non Timber Forest Products in the Bolivian Amazon, 1991–2001 (US\$ 1,000)

	1991	1993	1995	1997	1999	2001
Soy and soy products	43,517	50,961	122,194	203,551	215,533	269,496
Sunflower products	67	987	2,067	6,821	13,935	27,214
Maize and sorghum	7,323	512	2,058	8,758	7,817	1,876
NTFP	7.7	–	187.0	5,657 ¹	2,567 ²	1,287 ³

Notes:

1 Palmito, silkworm, cochineal, copaiba, Brazil nuts.

2 Palmito, copaiba, cochineal.

3 Palmito.

Source: CAO data (1992–2002)

Preferential markets can also operate for industrial crops. The relentless fair trade/green trade emphasis in marketing for forest products has obscured the importance of preferential trading partners for industrialized grains within regional trading pacts. Kaimowitz and Smith (2001) have shown that markets for Bolivian soybeans within the Andean Pact countries and especially Colombia added US\$ 37 per ton to the return for Bolivian producers compared to their Brazilian counterparts — a significant addition to the average over the last fifteen years of US\$ 155 per ton. While conservationists saw ‘fair trade’ and green trade as a means to develop markets, Bolivian soy exporters profited from ‘unfair trade’ in segmented and preferential regional markets.

Another model to explain deforestation patterns relies on factor limitations, especially for capital (Mattos and Uhl, 1993). In this analysis, capital scarcity results in extensive low-intensity land uses — shifting cultivation or extensive pasture — rather than intensive ones. These low-intensity uses⁵ expand and stimulate deforestation. Increased capital availability then becomes the solution for encouraging intensive agriculture by enhancing the use of fertilization or agroforestry systems. By increasing the intensity of use on already cleared lands, rather than cutting forest for new agricultural lands, each hectare cleared remains in production.

While there are obviously situations where degradation-based deforestation may be slowed by access to inputs or even by other farming systems, the Bolivian soy frontier is not one of them. Increased capital availability does not appear to slow deforestation in this case, but rather to extend it, a dynamic that is increasingly noted in other deforestation/technology studies (cf. Angelsen and Kaimowitz, 2001).

Technology

Many researchers have argued that deforestation is driven by inappropriate technologies that provoke clearing as agriculture becomes unsustainable. As in the previous framework, deforestation is viewed largely as an outcome of land degradation, but in this case, technology rather than capital availability drives the system. These authors fall into two main camps — those favouring indigenous or autochthonous technologies (such as Posey and Balee, 1989; Redford and Padoch, 1993), or those promoting ‘green revolution’ technologies (such as Greenland et al., 1998). Both camps claim that with adequate technology, every hectare cleared would stay in production, and thus rampant deforestation, a result of farming instability, would be avoided.

5. Shifting cultivation is viewed in this literature as a degradation-driven land use, rather than a rotation system. Fertilization of pastures are assumed to enhance its sustainability, but see Fearnside (2001).

Much of the research along these lines emphasizes agroforestry systems and technologies for integrated cropping for small farms. Deforestation in Bolivia is driven not by extensive 'low-tech', but rather by extremely intensive 'hi-tech' genetic and mechanical production technologies. These throw into question the way that technology in Amazonian development has been traditionally understood. The focus of the appropriate/indigenous or green revolution technologies emphasized sustainable forest-based or peasant economies, but overlooked the enormous transformations that were occurring in the industrial agricultural sectors. Major technical breakthroughs were developing within Brazil during the 1970s which in the space of fifteen years would transform Brazil's acid soil Cerrados and southern flanks of Amazonia with more than 13 million ha of soybean (EMBRAPA, 2000). A third of Brazil's soy crop now comes from Legal Amazonia.⁶

Further Dynamics of Bolivian Clearing: International Investment

Most of the models currently used to analyse patterns of deforestation largely depend on *endogenous* features of regional production systems: local population, problems with property rights, prices, and policy distortions within a set of fairly local contexts (Anderson et al., 2002). The Bolivian case expresses the outcomes of these approaches as they unfold in the more globalized conditions of international technologies, markets, capital, and neoliberal development policies.

Tropical Latin American countries have gone through extensive institutional transformations and economic stabilization programmes which made national and international investment seem less risky. While 'globalization from above' has occurred, 'globalization from below', with the extensive clandestine economies of narcotics, gold and timber, also generates large revenues and is the source of investment capital. Steiner (1998) suggests that close to US\$ 4 billion were generated from Bolivia's coca economy in the period 1985–95, the key period of soy expansion, and interviews at CAO suggest that some of these revenues were invested in soy production. In addition, 'non-traditional' sources of international finance, such as Asian, Brazilian and Chilean capital seeking investment outlets, found an agreeable haven in Bolivia, facilitated by regional trading blocs such as the Andean Pact, and emergent trade among Mercosur countries. Thus in Bolivia, Brazilian soybean cartels, Malaysian loggers and Chilean pension funds also became sources of development funds. International colonization projects, such as those of the Japanese and the Mennonites, also supplied outside capital for mechanized soybean farm development. The habit of

6. From the EMBRAPA website: <http://www.embrapa.br/producao soja/SojanoBrasil.htm> (March 2004).

analysing capital sources as generally derived from the 'imperial north' needs to be recast. The impact of this dynamic is summarized in the changing role of Bolivian producers in its soy economy.

The rapid expansion of the agricultural frontier reflected the entry of some very powerful foreign economic actors, including Brazilian and Mennonite farmers and, to some extent, Japanese farmers. CAO data indicate that some 500,000 ha have been sold to Brazilian firms. These entrepreneurs all arrived with substantial experience in industrial agriculture and regionally adapted technical information and were thus able to implement development projects quickly. Table 6 outlines the production share of international farms in the soybean economy. At the beginning of the 1990s, Bolivian nationals controlled about 42 per cent of soy production; by the end of the decade their share had dropped to about one third. Meanwhile, Brazilian producers exploded into the region in the mid-1990s, and by the end of the decade controlled 31 per cent of production. Mennonites and Japanese farmers who had been initially responsible for the introduction of soy accounted for 57 per cent at the beginning of the decade, but retained less than 30 per cent of production by its end. The Japanese were more or less limited to the terrains of the Okinawa colonization project, and their production remained relatively constant from the mid-1990s to the end of the century. 'Others' — a collection of nationalities including Russians, Canadians and Finns — substantially increased their share of production from 1 per cent to 8.5 per cent by the end of 2001. Thus, almost 70 per cent of the Bolivian soy crop is grown by foreign producers and firms.

Implications of the Agro-Industrial Frontier

Woodlands in South America are in the midst, once again, of a serious wave of deforestation. Explanations for why forests fall, and the relevance of recommendations derived from these explanations, now require a much more careful assessment in the light of institutional changes in the national states, new regional development ideologies, global and regional economic integration, scales of production, changes in conservation doctrines and novel tropical technologies. Most of the kinds of market policies that were thought in the 1980s to slow deforestation by enhancing intensification — privatizing property, improving technology, increasing capital availability (including foreign capital) and participating in segmented markets — were the same neo-liberal recommendations on offer for stimulating development of the intensive agro-industrial sector. There has been a qualitative shift in the nature of these frontiers and in regional development approaches. What then are the current implications for the Bolivian (and Brazilian) agro-industrial frontiers?

Table 6. Nationality of Lowland Soy Producers, by Area (ha) and Percentage of Soy Crop

	1990/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01
Bolivian (ha)	62,980	59,393	67,690	86,760	108,200	104,511	130,800	123,370	131,760	132,000	155,000
%	42%	36%	39%	36%	33%	27%	30%	25%	26%	26%	32%
Brazilian (ha)	—	—	2,489	19,075	64,800	104,645	136,100	174,530	166,700	157,000	152,000
%	—	—	1.4%	7.8%	20.9%	27%	31.4%	36%	33%	32%	31%
Mennonite (ha)	73,520	87,246	90,390	103,490	121,500	141,814	123,400	136,500	142,330	138,500	110,000
%	49%	53%	52%	43%	37%	36%	28%	28%	28%	28%	22%
Japanese (ha)	12,000	13,746	9,817	27,700	32,700	27,900	34,500	38,800	37,800	32,800	32,000
%	8%	8.2%	5.6%	11.5%	10%	7%	8%	8%	7.9%	7%	6.5%
Others ^a (ha)	1,500	4,535	5,230	nd ^b	2,800	11,800	8,700	12,500	30,450	31,200	41,000
%	1%	2.8%	3%	—	.85%	3%	2.9%	3%	6.9%	6%	8.5%

Notes:

Percentages have been rounded.

a) Includes Russian, Canadian, US and another national groups.

b) No data recorded.

Source: CAO (1996, 2001)

The peasant/pasture frontiers that unfolded in the Amazon forests from the mid-1960s to the late 1980s in both Brazil and Bolivia were dominated by ideas about regional occupation that expressed the social functions of land and were needed to legitimize the authoritarian regimes that implemented the policies. The goals of these Amazon efforts were both deeply political and historical, and had much to do with what Scott (1998) calls ‘authoritarian modernism’—administrative ordering of nature and society, unrestrained use of the modern state as the means to achieve these ends, and a weakened and repressed civil society with a limited ability to resist these incursions. While economic returns were part of the picture, the broader concern was one of a technified vision of social progress mobilized around three central themes: the iconography of manifest destiny, progress/modernization and agrarian reform, achieved through the discipline of central planning and co-ordinated by regional agencies such as Cordecruz (Bolivia) and Sudam (Brazil). While the overarching macro policy of this period was defined by Import Substitution Industrialization (Hecht and Cockburn, 1989; Pacheco, 2001, 2002, 2003), the underlying frontier dynamics in Bolivia and Brazil expressed important political and symbolic needs of authoritarian regimes.

Amazonian occupation reflected geopolitical concerns induced by the Cold War, local insurgencies, and longstanding historical suspicions about Amazonian annexation by neighbouring states.⁷ The occupation of the Amazon further embodied the deeply nationalist project, extending ideas of manifest destiny in much the same way as this idea animated the conquest of the western US frontier. In both Bolivia and Brazil, it reinforced the view in authoritarian circles of the special historic role of the military in advancing the national interest through its capacities for nation-building and spatial integration. The revolutionary military in Brazil felt that it was uniquely positioned to supervise regional development in the face of the ‘irreconcilable interests’ in civil society (Skidmore, 1988; Stepan, 1971). Amazonian enterprises were seen as means of countering uneven regional development through a combination of infrastructure, large-scale projects, induced development, growth pole activities and infusions of population (Matteiro-Mattos, 1980). The (subsidized) entry and support of the most modern entrepreneurial sectors into Amazonia’s rural economic landscapes was meant to shift rural activities from pre-capitalist forms of labour mobilization and production into a waged and technified frontier by replacing traditional land uses with modern ones, customary tenure with private property, and client relations with waged exchanges.

Not surprisingly, intense conflict occurred when the modern systems ran up against more traditional forms such as indigenous holdings, extractive

7. Historically Brazil was the master of Amazonian annexation. Under Baron Rio Branco at the beginning of the twentieth century, an area the size of France was added to Brazil’s territory.

systems, artisanal mining and some long-established peasant economies (Hecht and Cockburn, 1989; Schmink and Wood, 1992). Both Brazil and Bolivia looked to modernized outsiders — Brazilian agro-industrialists, Mennonites, Japanese colonists — to provide a kind of ‘demonstration effect’ for the transformation of local economies. This approach was also meant to shift Amazonia’s iconography from those of wild frontiers, to modernist, ordered production utopias through the application of scientific principles. The trade magazine for Brazilian Amazonian investors — *Amazonia* — regularly included enormous vistas of Amazonian holdings in its articles and advertising.

The Amazon was also portrayed as an alternative to agrarian reform. Vast areas of state lands meant that the politically disagreeable tasks of expropriation for redistribution could be avoided, and the clamour for land that had been a constant theme within agrarian politics in the post-war period could be quelled through a massive enclosure movement of Amazon territories. Presented as a poverty-alleviating measure for the perennially destitute northeast, the TransAmazon was constructed to link with the road network that ties Amazonia with TransAndean roads, and the river and road systems to the south. In a similar manner, the decline of the tin industry throughout the 1960s and the impoverishment of Andean mining communities stimulated some of the formal colonization exercises in Bolivia. The continuing formal and informal colonization projects in the Amazon were always portrayed as frontiers of opportunity for small farmers throughout Brazil and Bolivia, which reinforced Amazonia as a symbol of social mobility more than a national economic agenda: ‘A land without people, for a people without land’.

As Amazonian deforestation increased and the international outcry intensified, and as the hoped-for ‘ordered frontiers’ dissolved into a kind of land and resource frenzy, multilateral lenders, national and international environment agencies all pressed for set-asides. In the context of the social and political functions of land, within what was seen as a majestic historical project, protection of national patrimony could be argued as part of modern rational development. While certain interests may have been opposed to conservation of specific sites, with centralized governance, and vast areas of public lands, it was relatively easy to implement conservation areas, and environmentalists overall were surprisingly successful. By 1991, 80 per cent of the conservation areas in existence in Amazonia had been inaugurated under centralized and largely authoritarian regimes (Roja and Castano, 1991). The arguments for large-scale conservation were articulated in non-economic frameworks of science and patrimony in policy, planning and land use. Arguments were made for large parks, and these can be seen as being as pharaonic as the immense dams, mines and infrastructure in the spatial shaping of landscape. In the mid and late 1980s, the social function of land was further expanded when the rigid restrictions on human presence in conservation units was relaxed (Garfield, 2002; Hecht and Cockburn,

1989) and the implementation of extractive, sustainable development and expanded native reserves during the 1990s began (Cardoso, 2002; Little, 2002). As a consequence, about 28 per cent of Amazonian forests in Brazil are now in some form of conservation holdings.⁸

THE NEOLIBERAL FRONTIER: NEW CONTEXTS, INSTITUTIONS AND IDEOLOGIES

The late 1980s witnessed the political opening of many Amazon countries, the end of the Authoritarian period, transitions to democracy, emergent decentralized governance, trade liberalization and the discipline of structural adjustment programmes. With elections at all levels, the legitimacy of national and local governments was no longer in question, decentralization and structural adjustment were seen as ridding regional development from the vices of centralized planning and the array of corrupt subsidies and cronyism that had characterized the earlier frontier iterations. The fall of the Soviet Union made the questions of the Cold War and the spread of communism moot. With more than twenty years of active state intervention in Amazonia, actors from both the left and right were relieved that the role of the state would be reduced, and a broader arena for local determination could open up. Under the new neoliberal regimes, markets rather than the state would drive development forward in the most efficient manner. With decentralization, localities would, in principle, have more determination over forms of development. While the state would remain involved in constructing infrastructure and in technology adaptation, and would elaborate the policy instruments to facilitate market integration, the questions of Amazonian development were more or less up to enterprises and NGOs to negotiate.

Amazon development as a part of broader social and political concerns was eclipsed by the idea of development as a fundamentally *economic* endeavour, mediated and organized by markets. In this context the enterprises and NGOs increasingly describe the contours of the new institutionality. In the earlier period, when the pasture/peasant frontier with its relatively low economic returns bumped up against the array of values embodied in forests, the actual and purported revenues could indeed exceed the return to the replacement land uses. This is not necessarily the case on the soy frontier, where its massive revenues — the Brazilian soy crop was valued at US\$ 34 billion in 2003⁹ — undermines many of the valuation

8. About 20 per cent of Legal Amazonia is in indigenous areas, 4 per cent is in sustainable use areas (national forests, extractive reserves), and 4 per cent is in complete protection as National Parks and Biological Reserves.

9. From the EMBRAPA website: <http://www.embrapa.br/producaosoja/SojanoBrasil.htm> (March 2004).

arguments, and justifies extensive and costly infrastructure programmes like *Avana Brazil*. While researchers are addressing this issue as it applies in Amazonian high forests (see Fearnside, 2003a; Laurance et al., 2001; Nepstad et al., 2001, 2002), the more desperate questions are being posed in the Basin's 'throw away forests' — the southern arc of the basin characterized by savanna, transition and semi-deciduous forests.

The rampant deforestation in Amazonia's 'arc of fire' that extends from Maranhao to Santa Cruz reflects a powerful economic dynamic, a kind of market and technology triumphalism. However, three elements of the current environmental epistemology have limited conservation actions when faced with the task of slowing the rapid immolation of transition and open forest formations. These include 'high forest bias', the rise of the 'Hotspot' discourse, and the history of 'development diversion' for safeguarding high biomass tropical forests.

High Forest Bias

The overwhelming attention to high biomass, humid tropical forest formations in Amazonia deflected the concerns of many conservationists away from semi-deciduous forests, savanna woodlands and extensive areas of high diversity tropical anthropogenic forests. These areas were seen as essentially uninteresting from a biologic standpoint, and widely modified by human action, especially fire. Recent research, however, has shown that these forests are much more complex and diverse than previously thought (Brown and Gifford, 2002; Killeen et al., 1998; Ratter et al., 1997); the Brazilian Cerrados, for example, are home to some 10,000 species (Oliveira and Marquis, 2002).

This bias toward humid tropical forest had the result that areas such as the Cerrados were not even included in the idea of national environmental patrimony in the 1988 Brazilian Constitution, and thus no provisions were made for their protection. Unlike high forest or transitional forests, Brazilian law does not stipulate the maintenance of a portion of Cerrado lands when converting to other uses. *Planaforo*, the most elaborated of Brazilian land use planning exercises, was also largely apathetic about the Cerrados and *Cerradao* (closed Cerrado) of Rondonia. Similarly, Bolivia's land use zoning exercise, *PLUS*, which began in 1989, had virtually no protected areas built into the semi-deciduous low forest zones, except those occupied by native populations.

Hotspots

This indifference to the enormous biome of open forests was further buttressed by the emergence of the ideas of 'hotspots' in conservation approaches (Myers et al., 2000). In this view, set-asides in areas that

harbour high levels of diversity and endemism permit more cost effective conservation, since hotspots embrace more biodiversity in relatively smaller areas. Concentrating conservation efforts on these sites thus achieves preservation goals while releasing other lands from the development constraints that might otherwise apply. There have been widespread critiques of this approach, largely based on questions of knowledge of regional levels of biodiversity, forms of biodiversity, and the importance of environmental services that are achieved through more extensive kinds of systems (Kareiva and Marvier, 2003). However, the lack of concern about lower biomass forests until the late 1990s meant that these open and drier woodlands were literally mowed down. About 70 per cent of the Cerrados have been affected by human action with more than a third definitively transformed (Klink, 1996; Klink and Moreira, 2002). While Cerrado areas in Brazil were catapulted into 'hotspot' status after a priority-setting workshop in 1997, many of the most critical areas had already been lost, positioned as they were in the path of oncoming infrastructure and agriculture development (Fearnside, 2003b).

Deflected Development

For those who had been most involved in conservation during the heyday of the Generals, a desire to reorient development from tropical high forests to the Cerrados had been mooted in policy circles since the early 1970s as a means of avoiding a deforestation and development debacle in Amazonia (Goodland and Irwin, 1975). The continuous focus on Amazonian conservation meant that the enormous transformations of the more open woodlands were hardly noticed until they began to nibble at the edges of Amazonia. Less than 1 per cent of the open forest formations have been protected, while more than 65 million hectares have been converted to other uses (Klink and Moreira, 2002).

The combination of neoliberal reforms, market-led development and a history of environmental indifference to these open forest ecosystems means that these areas are now highly vulnerable to an intensive growth frontier whose expansion will be further stimulated by the massive multi-modal infrastructure developments for the Amazon Basin and trans-Andean transport systems (Fearnside, 2001; 2003a; Nepstad et al., 2001).

Conservation Strategies at the Neoliberal Frontier

The traditional means of promoting conservation are relatively frail for these forest systems, in part due to the economic and political power of the replacing land use, and partly because the available policy instruments are not especially adapted to this context. The first and most elaborated method for conservation, set-asides, has come late in the game for these

areas. Some land purchases are underway, but, unlike the high forests of Amazonia, there are relatively few native reserves — not least as a result of the area's earlier genocidal history (see Garfield, 2002). Some regulation of deforestation is now occurring, for instance in areas of Mato Grosso, where the National Environmental Insitute is monitoring the clearing of large sites and imposing fines. This does seem to be slowing the rates of some types of clearing, but as Fearnside (2003a) points out, the recent election of Brazil's soybean baron, Bruno Maggi, as Governor of Mato Grosso might well eliminate such monitoring.

The appeal to social movements, native and traditional peoples is also relatively weak since most of this development occurs at established frontier areas in Mato Grosso, Rondonia, the Expansion Zone and southern Para — areas that are dominated by larger holdings with clear titles, whose times of turbulence are now often decades in the past. The arguments that were historically used to counter large-scale expansion — that it was inequitable and unproductive — are less effective at these types of frontier, since conflicts over property relations have largely been resolved. 'Legitimacy' is conferred by elections, and 'economics' rather than the state or a formally arbitrated political process are now seen as the regional determinants of development. The real space of political action is relatively narrow, in spite of the laws of popular participation.

While the traditional techniques for dealing with 'pristine systems' may have some limited success, the emphasis on the soy frontier should increasingly focus the strategies for biotic enrichment in anthropogenic landscapes. While a great deal of conservation effort has denigrated forest fragments as moribund landscape elements, the new approach could emphasize the value of such fragmented ecosystems, corridor forests such as the gallery forests found widely throughout the region and protected by laws designed for watershed and erosion management. Efforts that emphasize landscape texture — the 'matrices' — need to receive higher policy priority as both regional conservation and development goals. This kind of 'countryside' conservation may not be possible everywhere on the soy frontier, but corridors, successional systems, forest fragments, windbreaks, living fences, arboreal land demarcations, urban forests, municipal parks, suburban open space and agropastoral formations need to be viewed as the emerging centre of conservation policy and action. This means viewing humanly manipulated forests as central to a conservation strategy, and concentrating much more research on the dynamics of these systems. Research from Central America has emphasized the important contributions of such anthropogenic landscapes in terms of significant diversity maintenance and environmental services (Daily et al., 2002; Hecht et al., 2002, 2005). Since these more open systems have been extensively manipulated, ecosystem enrichment and management approaches are vital, as these resilient areas in human-dominated ecosystems may be able to sustain more diversity and biomass than we know.

There is much to be learned from Amazonia's socioecology and indigenous knowledge, such as the creation of forest islands in open savanna areas, management of forest grassland mosaics, the enrichment of soils through the creation of charcoal rich substrates, the techniques for planting and using native species in open landscapes, the development of silvopastoral systems, and the enrichment of gallery forests. The peasants to the north of Santa Cruz, with their rotational agricultural systems, also have lessons to contribute, as do the Guarani of Paraguay, whose vast *yerba mate* forests were also victims of the soy frontier. Many other examples could be cited.

South America's open forest biomes have been largely viewed as a kind of development substrate by environmentalists as well as entrepreneurs, places that didn't really count as resource-rich. Researchers are increasingly surprised at the complexity and significance of these areas, especially in the face of clearing rates greater than those of classic high Amazon forests (Klink and Moreira, 2002). The growing attention to these regions is heartening, but the key to their survival will be at the borders of soyfields, pastures, towns, remnants and waterways. The conservation of at least part of the complexity of these forests will shift the optic to Amazonia's margins, which will increasingly become the real centre for imagining what conservation in the age of neoliberalism might look like.

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