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COMMENT

Will urbanization cause deforested areas to be abandoned in Brazilian Amazonia?

Wright and Muller-Landau (2006) proposed that rural–urban migration could reduce tropical forest loss worldwide and allow secondary forest to occupy abandoned clearings, thereby reducing the expected magnitude of tropical species extinctions. However, the usefulness of this global generalization is highly dependent on its being correct for Brazilian Amazonia, which has the world's largest remaining area of tropical forest. Among the features of the deforestation process that make urbanization an unlikely mechanism for land abandonment in Brazil is the fact that most deforestation is done by ranchers rather than by shifting cultivators. A family of shifting cultivators is only capable of farming a limited area and cannot greatly expand the area it cultivates if additional land becomes available. Ranchers, by contrast, can occupy huge areas and expand their holdings when the opportunity arises. Were part of the population to leave for the cities their land would usually be bought by neighbouring ranchers who would maintain and expand the deforested landscape. As Wright and Muller-Landau (2006) predicted, their interpretations have generated considerable controversy (Brook *et al*. 2006; Gardner *et al*. 2007; Laurance 2006; Sloan 2007). Only part of this controversy will be considered here, namely the expectation that rural population in tropical areas will decline, allowing secondary forests to regrow in large areas of abandoned farmland. Specifically, the present paper will consider the applicability of the Wright/Muller-Landau hypothesis to Brazilian Amazonia.

Importance of Brazil

Brazil had 41% of the world's remaining tropical rainforest in 1990, the last year the Food and Agriculture Organization of the United Nations (FAO) tallied statistics for rainforests (FAO 1993). Of all 'primary' forests in the world in 2005, Brazil had 31%; after Brazil, the major tropical countries were Peru (5%), Colombia (4%), Indonesia (4%), Mexico (3%), Bolivia (2%) and Papua New Guinea (2%) (FAO 2006). When cross-national studies compute the effect of different variables on deforestation rates, each data point usually represents one country, and all points have equal weight. Great variation exists among countries in terms of the forces most important for deforestation. If the resulting generalization is to be true at a global scale, Brazil must fall right on the regression line.

The dynamics of deforestation in Brazilian Amazonia suggest that the effect of rural-urban migration would be minimal. Unlike some other parts of the world, most deforestation in Brazil is not caused by shifting cultivation, but rather by large (>1000 ha) or medium-sized (100–1000 ha) ranchers (Fearnside 1993). The deforestation rate would not decline proportionately were part of the small-farmer population to leave for the cities. A pattern repeated many times has been initial clearing by small farmers, who may be either 'colonists' (legal small farmers in settlement areas) or squatters, followed by consolidation into larger ranches, either by purchases or by violent expulsion by large ranchers and *grileiros* (landgrabbers) (Fearnside 1986).

Deforestation dynamics

Will urbanization cause a depopulation of the Amazonian interior with consequent expansion of secondary forests? The underlying assumption is essentially that the rural population is like a jar full of marbles. If you take some of the marbles out of the jar, the volume of remaining marbles decreases proportionately. But what if the marbles are of very unequal size and it is primarily the small ones that are removed? What if the size of each marble is not fixed and the remaining marbles simply expand to fill the space that has been made available? Both of these characteristics apply to rural-urban migration in Brazil.

An example is provided by the colonization projects where land was distributed as small settler lots by the National Institute for Colonization and Agrarian Reform (INCRA). Many of the small lots were soon bought by wealthier colonists or newcomers and consolidated into small ranches in settlements on the Transamazon Highway and Paraupebas areas in Pará, the BR-364 Highway in Rondônia and in the Apuí area in southern Amazonas (Fearnside 1986, 1989, 2001*a*; Razera 2005).

Cattle pasture is the dominant land use in areas where tropical rainforest has been deforested in Brazilian Amazonia, even after the entry of soybeans as an additional actor beginning in the 1990s (Fearnside 2001*b*). A minimal human population can maintain a large area in pasture, greatly magnifying the population's impact (Fearnside 1983).

Rural-urban migration exists, but it is not as important for deforestation as might appear to be the case. Ranchers, especially large ranchers, often live in urban areas. When these people move from the rural zone to a city, their effect on deforestation continues. The urban connection can even increase deforestation because money from urban sources

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(including corruption and tax evasion) is invested in deforesting and expanding rural holdings.

Most rural–urban migration does not involve ranchers. Those who move to the city are often not from deforestation frontiers. In the state of Amazonas, much of the migration to Manaus is from riverside farms and small riverside towns along the Amazon River and the Rio Negro, not from the places where deforestation is accelerating in the southern part of the state. The individuals who move to urban areas are often not the deforesters in the population. Women often accompany children who move to the city for better school opportunities. Elderly people make the move to accompany family members and for better health care. The young males stay in the interior and continue to clear forest. The sex ratio in many of these frontier areas is heavily skewed towards males (Sawyer 2001). This is even evident in municipal-level census data, where lumping of the municipal seat with the rural area cancels out some of the effect. For example, in the state of Amazonas, in the municipality that includes the capital city (Manaus), men made up 48% of the population over 10 years of age in 2000, while in interior municipalities the proportions were reversed: 55% men in Apuí, 53% in Lábrea and 53% in Manicoré (Brazil, IBGE [Instituto Brasileiro de Geografia e Estatística] 2008). In frontier areas the age distribution is skewed towards those in the prime of life (Sawyer 2001). It is common to meet older people in the city who have spent a lifetime moving between different frontier areas, but moved to the city after suffering an injury or becoming too old for the work they had been doing.

Several trends are underway that increase clearing. One is the increasing sale of beef for export (Smeraldi & May 2008). A growing number of Brazilian states have been certified as free of foot-and-mouth disease, a disease in cattle which blocks export of frozen beef to markets in Europe, North America and Japan. The certification process began in 1998 with Rio Grande do Sul and now includes five of the nine Amazonian states. Likely future forces speeding deforestation include biofuels from sugar cane and palm oil, more pasture for supplying the international beef market, expansion of soybeans and timber harvesting. All of this suggests expansion, rather than abandonment, of areas under human use.

Dynamics of land abandonment

Why is land abandoned to secondary forest? The assumption of Wright and Muller-Landau (2006) that this will occur because shifting cultivators have moved to the city and left their land abandoned does not fit the norm in Brazilian Amazonia today.

The threat of agrarian reform can be a motivation for ranchers clearing secondary forest, as this clearing prevents the property being classified as 'unproductive' by the National Institute for Colonization and Agrarian Reform (INCRA), which can lead to the land being expropriated for distribution to landless farmers. The presence of secondary forest can also attract invasion by landless peasants in the expectation that the land will be expropriated. This, together with greater profitability of ranching for beef production, has resulted in a noticeable reduction in the area of secondary forest. I travelled across northern Mato Grosso in 1986 and again in 2006; the contrast was evident between large areas of abandoned cattle pasture reverting to secondary forest in 1986 and the same areas in productive pasture stocked with cattle in 2006 (P. Fearnside, personal observation 2006). The general drawdown of secondary-forest areas in the arc of deforestation is contrary to the trend predicted by the Wright/Muller-Landau hypothesis.

The process of small farms being consolidated into large farms has also taken place in south-central Brazil (Dean 1995); this process does not mean that the land is abandoned. This is often referred to as the 'hollow frontier', where the relatively densely populated fringe of the deforestation frontier advances into the forest, leaving behind a sparsely populated landscape of ranch land. It is combined with a frontier 'retraction' process linked to expansion of capitalist activity, but does not imply land abandonment (Sawyer 1984, pp. 197–202).

Urban effects on deforestation

Urbanization by population movement from the countryside to cities and towns is an important demographic change in Amazonia as elsewhere. As of 2000, 69.8% of the population of the seven-state Northern Region (the Legal Amazon minus Mato Grosso and Maranhão) was classed as urban (Brazil, IBGE 2000). However, part of the urbanization indicated by these statistics is not the result of rural–urban population movement; urban-urban migration from other parts of Brazil makes a substantial contribution. In addition, part of the 'urbanization' of the Amazon is the result of small towns growing past the threshold that defines them as urban, or results from towns becoming municipal seats and thereby automatically being classed as urban. This results in the entire populations of these towns being reclassified from rural to urban. The number of municipal seats continually increases because there is constant pressure to create new municipalities, which augments political representation, government subsidies and lucrative positions on the government payroll (as well as stimulating deforestation).

Browder and Godfrey (1997) have compiled the most complete study of urbanization processes in Amazonia to date. They conclude that 'the urbanization of the Amazon's rainforest has ambiguous environmental impacts' because, although smaller areas are cleared by urban-based farmers, the indirect effects that are pushing in the opposite direction counterbalance this effect (Browder & Godfrey 1997, p. 342). Urban-based farmers have 'more casual and unproductive land use' (i.e. pasture). They also have more money and influence, such that 'small farmers are often only the pawns in the deforestation spectacle dominated by urban groups' (Browder & Godfrey 1997). In addition, the demands of urban residents amplify impact on the surrounding forest through

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demand for wood, charcoal, agricultural products, electricity and weekend leisure establishments.

Conclusions

Deforestation is unlikely to lead to significant expansion of secondary forests in Brazilian Amazonia, or to provide much relief from deforestation pressure in this the world's largest tropical forest. The notion that the danger of a tropical deforestation 'crisis' has been exaggerated by ignoring attenuating effects of urbanization is not supported by trends in Brazil.

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PHILIP M. FEARNSIDE
Instituto Nacional de Pesquisas da Amazônia-INPA
Av. André Araújo, 2936 cp 478 69.011-970
Manaus-Amazonas, Brazil
Tel: +55 92 3643 1822
Fax: +55 92 3642 8909
e-mail: pmfearn@inpa.gov.br

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