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COMMENTARY

Fewer People May Not Mean More Forest for Latin American Forest Frontiers

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IN "THE FUTURE OF TROPICAL FOREST SPECIES" WRIGHT AND MULLER-LANDAU (HEREAFTER WML) (2006: 287) assert that "humans cause deforestation, and humans living in rural settings have the greatest impact on extant forest area in the tropics." They point to a positive correlation observed between human rural population density and deforestation to support their assertion. WML correlate rural population densities for 45 Asian, African and American countries with the proportion of "potential" forest remaining in each, subsequently explaining 76 percent of deforestation to date. WML then project future net tropical deforestation until 2030 using rural population projections. On the basis of the population-deforestation relationship, WML conclude that anticipated declines in rural populations via urbanization will herald net afforestation, particularly in Latin America.

Drawing from the social science literature on land-use/cover change in tropical forests, I challenge WML's key analytical assumption that declines in rural population density after deforestation has occurred will result in widespread afforestation. WML do anticipate such challenges with their caveat that should land use become less labor intensive in future, then their predictions will be overly optimistic (2006: 295). WML fail to appreciate, however, that in Neotropical forest frontiers: (1) regrowth suppression via land-use extensification is a characteristic outcome of population decline; and (2) exogenous drivers of land-cover change are increasingly diminishing the role of local population in such change. These tendencies are both well established and ongoing, so challenging WML's predictions from their onset. I focus primarily, but not exclusively, on Latin America, as WML view this region most optimistically as an illustration of their expectations.

WML's predictions reflect the broad assumptions of the forest-transition thesis, a summary explanation of the convergence of afforestation, urbanization and agricultural land abandonment based on historical, temperate-nation precedents (Mather & Needle 1998, Rudel 1998, 2005). In this, WML neglect Latin America's primary drivers of deforestation, its rural populations' distributions and redistributions, and the increasing influence of non-local drivers of land-cover change. These factors have a profound influence on deforestation rates and our ability to predict them via population figures. This is apparent upon considering Neotropical forest frontiers, such as Panama's Darién, Guatemala's Petén or Brazil's Amazon, where much forest cover remains and deforestation rates are high.

The Darién frontier comprises less than 20 percent of Panama's national area but approximately 40 percent of its forest cover (ANAM 2003). During the 1970s peasants colonized the region, claiming land and opening forest for small agricultural plots (Wali 1989). Forest conversion for short-term gains in livelihood characterized this early "extractive" stage of frontier development (Heckadon Moreno 1981). Populations were unable to maintain yields and efficiencies, and many subsequently abandoned lands or sold out to larger interests (*cf.* Thiele 1993). Notably, more successful colonists remained by extensifying land use, namely by converting their land to pasture. An expulsive stage inevitably resulted as relatively few expansive landholders replaced more numerous smaller farmers.

This expulsive settlement stage contradicts WML's assumptions regarding the population-deforestation correlation. During this stage, 30 percent or more of an agricultural population may abandon their lands while those who remain suppress regrowth by expanding over the formers' lands and into surrounding forest. In the southeastern Bayano Region, the Darién's most populous front, this stage has been underway since 1990; between 1990 and 2000, the population decreased by nearly 20 percent, but pasture area increased by nearly 50 percent and the number of cattle by 100 percent (Controlaria 1991a,b, 2001a,b). The Bayano Region thus became a "hollow" frontier as declining population density coincided with regrowth suppression.

The concentration of remaining Neotropical forest in frontiers isolated from most populations also makes problematic WML's use of national-scale correlations to predict deforestation. Table 1 presents forest cover and rural population for the Panamanian district of Chepo, encompassing the Bayano frontier, and for the interior province of Los Santos. Population pressure mounted in Los Santos during the post-war period, and by the 1960s Santeños had begun migrating cross-country into Bayano's dense forests (McKay 1976, Heckadon Moreno 1981). Table 1 demonstrates that observed regional-scale dynamics accord poorly with WML's aggregate-scale assumptions. In Chepo, a mere increase from 3.8 to 4.2 residents per km^2 coincided with 451 km^2 forest cleared (8.5% of the total area) between 1990 and 2000, a seemingly disproportionate outcome until one recalls that, at the frontier, ongoing

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TABLE 1. *Rural population densities and forest cover for the province of Los Santos and the district of Chepo (Bayano Region), Republic of Panama, 1960–2000. Areas of Los Santos and Chepo are 3867 km² and 5308 km², respectively.*

	1960	1970	1980	1990	2000
			Rural population density (residents per km²)		
Los Santos	16.5	16.7	15.4	16.5	17.7
Chepo	<1.0	2.2	2.6	3.8	4.3
			Rural population		
Los Santos	70,544	72,380	70,261	76,947	83,495
Chepo	4573	11,881	13,664	20,174	22,766
			Forest cover (km² and % total area)		
Los Santos	†	186 (4.8%) [bc]	†	212 (5.4%) [cde]	279 (7.2%) [cd]
Chepo	∼4800 (90.4%) [a†]	†	†	3182 (61%) [d]	2731 (51.4%) [cd]

Sources and Notes:

Population Data: Controlaria (1991a,b, 2001a,b).

Forest Cover Data:

[a]Map-based estimation based on expert sources.

[b]Estimation for 1973.

[c]Author's satellite imagery-derived estimations.

[d]Satellite-imagery derived estimations by ANAM (2003).

[e]Estimation for 1988.

†Cloud cover prohibitive of satellite image-derived estimations, or satellite imagery not available for the period.

emigration coincides with deforestation. Contrastingly, in the crowded Los Santos, greater increases in density have coincided with steady afforestation since 1970. Thus, and particularly in the case of the frontier, the tabled data are not only distinct from each other in nature but are distinct from what WML's national-scale correlations suggest are necessary for similar levels of deforestation (their Fig. 2). In fact, the population densities of Chepo are negligible, averaging 2.7 rural residents per km² for the period 1960–2000, yet there, nearly 2000 km² (37% of the total area) have been deforested. The explanation for such discrepancies lies not with population but rather with the specific population-deforestation relationship between drivers of land use and outcomes on the frontier (*e.g.*, Perz & Skole 2003), mediated by socio-economic factors and discernible only through regional-scale correlation analysis (*e.g.*, Rudel & Fu 1996).

The hollow-frontier dynamic is evident throughout Latin America. Since the 1970s it has consistently typified land-cover change from Brazil (Foweraker 1981, Wood & Skole 1996, Fearnside 2001, Brown *et al.* 2004, Simon & Garagorry 2005) to Bolivia (Stearman 1983, Thiele 1993, Steininger *et al.* 2001, Hecht 2005) to Colombia (Ortiz 1984) to Central America (Jones 1989) to Ecuador (Pichón 1997, Rudel *et al.* 2002) to Mexico (O'Brien 1999) and beyond. The ubiquity of the dynamic challenges WML global analysis, for theirs is merely an aggregation of already overly aggregated national-scale data (Table 1). Today, globalization is bolstering the hollow-frontier dynamic by promoting various land uses other than pasture: witness the consolidation of ranchland into pineapple plantations in Costa Rica, or the clear tendency for agro-industrial soy to succeed pasture in Brazil (Brown 2005). Such are "neoliberal frontiers"—a "kind of market and technological triumphalism" that exaggerate the hollow-frontier dynamic (Hecht 2005: 376, 397). Depopulation may continue even among those groups remaining from earlier periods of emigration (Fearnside 2001), but now more regrowth is suppressed over even greater expanses by increasingly exogenous actors. As a result, land-cover change becomes even less explicable by local population dynamics.

The Bolivian Amazon provides an example. Prior to Bolivia's neoliberal reforms commencing in 1985, the deforestation rate in its "Tierras Bajas" was 0.45 percent per year, divided equally between slash-and-burn farmers and industrial agriculturists (Steininger *et al.* 2001). Deforestation quickened as the reforms deepened, yet only among industrial agriculturalists (Vilar & Kupfer 1995), reaching 5–6.3 percent per year (Steininger *et al.* 2001), to which a displaced population contributed very little. Among peasants and colonists—the rural residents that concern WML—annual forest clearings declined by ten percent (3480 ha/yr) and cropping areas (in corn and rice) by 50 percent (28,700 ha) from the culmination of the reforms in 1994/1995 to 2000 (Hecht 2005). Simultaneously, annual clearings among agro-industrial and large-scale Mennonite "rural residents" increased by at least 25 percent (a comparably huge 69,212 ha/yr) and cropping areas in soy and sunflower continued to rise (Steininger *et al.* 2001, Hecht 2005). Over the period 1986–2000, some 1,604,010 hectares, or 87 percent of forestland converted to agriculture, ultimately passed into large-scale, "successive" industrial and Mennonite agriculture (Hecht 2005). The growing role of non-local actors cannot be understated—by 2000, three quarters of the area in soy, representing 60 percent of the total area cleared, was foreigner operated (Hecht 2005). Again, despite slash-and-burn farmers' diminished presence, regrowth was suppressed more extensively as successive land uses maintained previously cleared land in increasingly wide-open expanses (Steininger *et al.* 2001).

The growing influence of non-local drivers of land-cover change is expected to perpetuate such a dynamic in coming years (Rudel 2005). Increasing demand for meat and (feed) grains, both at home and abroad but particularly by newly affluent nations, is expected to favour further expansion into Neotropical frontiers rather than agricultural intensification, owing to a land abundance, a prevailing farm systems and demographic and social conditions which favour expansion (Alexandratos 1999). For Latin America, the International Food Policy Research Institute speaks of a "Livestock Revolution" as no less than the Green Revolution when describing the anticipated 80 percent growth in absolute demand for meat or the 45 percent growth in per capita demand for meat coincident with a 340 percent increase in meat exports by 2020 (Pinstrup-Anderson *et al.* 1997, 1999, Delgado *et al.* 1999). Pasture will be ascendant and increasingly managed by non-local enterprises (Delgado *et al.* 1999). Contrary to WML, the very urbanization hoped to diminish pressure on forests may fuel such "revolutions" as the adoption of meat-heavy urban diets coincides with increased rural land availability (Browder & Godfrey 1997, Humphries 1998).

Research to date on land-use/cover dynamics indicates that population alone predicts afforestation poorly because, contrary to WML's assumptions, it has little direct or consistent bearing on deforestation, "phenomenologically" or otherwise (Lambin *et al.* 2001, Geist & Lambin 2002, Carr 2004). To illustrate, Wood and Skole (1998) link satellite imagery of deforestation to municipal-level census data for the entire Brazilian Amazon. At this finer resolution, population density displays only a weak relationship with deforestation. "Rural immigration density" displays a stronger relationship, though it quickly declines as density, a proxy for slash-and-burn agriculture, becomes increasingly uncharacteristic of frontier deforestation over time. Indeed, upon disaggregating "cleared land" into "pasture" and "slash-and-burn" areas, the later proved insignificant and predicted no more deforestation than the former which, aside from being the strongest predictor by far, relates inversely to forest regrowth and population density. Thus, where the geographic and temporal scale of analysis coincides with that of deforestation, the population-deforestation correlation weakens considerably. Where the correlation is significant at forest frontiers, it is often only fleetingly so as deforestation assumes a land-extensive character over time.

Importantly, where institutional, economic or contextual factors are incorporated into the analysis, population-deforestation correlations are found to be spurious (Angelsen & Kaimowitz 1999) or even counter-intuitive (Rudel *et al.* 2005). In sparsely forested Kenya, for instance, Lamb and Gilmour (2003: 86–87) observe increasing tree cover with increasing rural population density. Indeed, woody biomass planted in farmland exceeds that of national forests, owing to rural residents' secure land tenure and high demand for wood products. Perz and Skole (2003) observe the converse at the municipality-scale in the Brazilian Amazon. In remote, sparsely populated municipalities tenure insecurity amidst forest abundance correlates negatively with forest regrowth—residents hedge anticipated losses of land by clearing more than necessary while being unwilling to invest trees in insecure property. In more populous, less forested Brazilian municipalities the relationship is again inverted (tenure insecurity correlates with more forest regrowth) owing to changing land use and higher farmer turnover. In sum, variables that determine rural residents' afforestation potential have inconstant relationships with changing population densities, leaving population as a poor predictor of forest cover over time and between regions.

It must be said that the debate concerning rural depopulation and forest-cover resurgence is one in which both sides appear to be correct, but only partially so. Clearly, forests will not fell themselves in humans' absence, and WML highlight the possibility for tropical reforestation following rural depopulation. Yet it is equally clear that deforestation does not require high population densities, and that reductions in population density do not necessarily reduce deforestation. What this debate needs most badly is a regional refocusing commensurate with the scale of land-use patterns and a careful consideration to such patterns. In Latin American frontiers, rural population density does not always correlate with deforestation, and may correlate inversely over time. The corollary is that urbanization and rural depopulation may not result in the anticipated forest recovery, again with potential perverse effects. For a genuine forest transition, urbanization will have to capture not only the slash-and-burn variety of rural residents but also the more expansive interests that succeed them. This may not be possible where non-local interests are the successors. As it is, population densities at the initiation of deforestation in tropical frontiers are often greater than those found in the hollow frontiers afterwards (Heckadon & McKay 1984). Therefore, the population-forest cover relationship from one period in time should not be directly applied to projections of future forest cover. Likewise, population-forest cover relationships at the national scale offer little insight into what is happening at the frontier. As most tropical forest of Latin America is found in frontiers, the fact WML's national-scale observations concerning population—a *proximate* driver of land-cover change (Geist & Lambin 2002)—are not observed at the frontier scale greatly qualifies their predictions. Such qualifications may average out over the very long term and at the very large scale; yet at the scale of the event in question such considerations are critical to theorizing a forest transition applicable to the tropics.

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