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SCIENCE DIRECT
Global Environmental Change 15 (2005) 23–31
GLOBAL ENVIRONMENTAL CHANGE
www.elsevier.com/locate/gloenvcha

Forest transitions: towards a global understanding of land use change

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Received 18 April 2004; received in revised form 27 September 2004; accepted 13 November 2004

Abstract

Places experience forest transitions when declines in forest cover cease and recoveries in forest cover begin. Forest transitions have occurred in two, sometimes overlapping circumstances. In some places economic development has created enough non-farm jobs to pull farmers off of the land, thereby inducing the spontaneous regeneration of forests in old fields. In other places a scarcity of forest products has prompted governments and landowners to plant trees in some fields. The transitions do little to conserve biodiversity, but they do sequester carbon and conserve soil, so governments should place a high priority on promoting them.

Keywords: Forest transition; Deforestation; Forest cover change; Land use

1. Introduction

In response to the twin specters of global climate change and worldwide habitat loss, networks of scientists began to create a science of sustainability during the late 20th century (Kates et al., 2001; Raven, 2002; Steffen et al., 2004). Participants in this endeavor searched for empirical regularities in our interactions with nature that could, if expedited by governments, accelerate the transition to a sustainable society (Kates et al., 2001). Alexander Mather coined the term 'the forest transition' to describe one of the first empirical generalizations to emerge from this work. Derived from historical studies of forests, this idea asserts that stocks of forests change in predictable ways as societies undergo economic development, industrialization and urbanization (Mather, 1990; Mather and Needle, 1998; Walker, 1993). A large decline in forest cover occurs; then the trend turns around, and a slow increase in forest cover takes place (Rudel, 1998). Given the wide variety of historical experiences with economic development and globalization, analysts might question whether or not forest transitions follow a single historical path from deforestation to forestation. FAO's recent release of forest cover change estimates for 139 nations for the 1990s provides an opportunity to assess this idea of variable forest transitions and explore its implications for efforts to create sustainable societies. We undertake these tasks in this paper.

2. Why should we care?: The environmental services of forest transitions

The significance of forest transitions in creating more sustainable societies depends on the effects of the

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doi:10.1016/j.gloenvcha.2004.11.001

transitions on the environmental services that forests provide. To gauge these effects, we briefly review the impact of forest transitions on hydrological cycles, soil conservation, climate change, and, to a lesser degree, the biodiversity crisis. While the effects of forest expansion on stream flows appear to vary with the size of watersheds, increases in forest cover should increase transpiration rates, reduce soil erosion and, by reducing sediment loads, improve water quality (Kramer et al., 1997; Ammer et al., 1995). Forest transitions also promise to slow the accumulation of greenhouse gases in the atmosphere by increasing carbon sequestration through the substitution of relatively carbon-rich secondary forests for carbon-poor agricultural land. As secondary forests age and the biomass per hectare increases, the amount of carbon sequestered per acre also increases (Houghton et al., 2000). For this reason the amount of carbon sequestered through a forest transition should increase over time as woody growth continues and the area covered by secondary growth expands. The total amounts of carbon sequestered this way have not been huge, but they have been visible. For example, carbon sequestered through secondary growth offset 3.3% of all of the carbon emitted through deforestation in the Amazon basin during the 1990s (Achard et al., 2004).

The impact of a forest transition on biodiversity varies from place to place. In many places endemic species will have gone extinct with the earlier conversion of old growth forests into fields, and invasive species will have established themselves in the disturbed habitats, so low levels of biodiversity will persist after regrowth. When forest expansion occurs through the conversion of fields or scrub growth into plantation monocultures, as it has in many forest scarce nations, the increments in biodiversity from a forest transition can be quite small (Spellerberg, 1996). In other places the re-emergence of secondary forests on uncultivated lands allows many species to recolonize an area, and, by extending the range of some species through migration and seed dispersal, regrowth probably reduces ecological fragmentation and prevents additional extinctions (Schelhas and Greenberg, 1996; Ferraz et al., 2003). High levels of biodiversity have been observed in the spontaneously generating understories of some plantations (Lugo, 1997).

Given the importance of these environmental services, it would be easy to accept the existence of forest transitions in an uncritical way. Because the transitions promise to solve some environmental problems without government intervention, some analysts may even want to use their existence as an excuse for not taking political action to address these problems (Easterbrook, 1995). Under these circumstances it behooves us to examine carefully the evidence for the existence and the origins of forest transitions.

3. The causes for forest transitions

Forest transitions begin during a period of deforestation. Initially, forests decline in extent as growing numbers of cultivators, with help from loggers, clear forested lands and convert them into fields in order to meet growing demands for food and fiber from human populations that reside, increasingly, in cities. Eventually, agricultural expansion ends. Arguments about forest recovery after agricultural expansion take two general forms. In one line of argument, farm workers leave the land for better paying non-farm jobs. The loss of laborers raises the wages of the remaining workers and makes more agricultural enterprises unprofitable. Under these circumstances farmers abandon their more remote, less productive fields and pastures.[1] These lands then revert to forest. The loss of farm laborers stems from urbanization and economic development, what Polanyi (1944) has called 'the great transformation' (Mather, 1992). We refer to this sequence of events as the 'economic development path' to the forest transition. Politicians reinforce this trend in forest cover when they arrange to purchase abandoned land for parks and forest reserves. Analysts who argue for the existence of an environmental Kuznets curve in forest cover change focus on this type of forest transition (Ehrardt-Martinez et al., 2002; Mather and Needle, 1999).

In a second line of argument, the loss of forests during agricultural expansion creates a countervailing tendency. In places with stable or growing populations and little ability to import forest products, continued declines in forest cover spur increases in the prices of forest products, and the price increases induce landowners to plant trees instead of crops or pasture grasses. This dynamic explains the recent increase in forest cover in India (Foster and Rosenzweig, 2003). We call this sequence of events the 'forest scarcity path' to the forest transition. Politicians accelerate this type of forestation when they create programs to reforest marginal lands in response to floods and rising prices for forest products.

These narratives presume particular understandings of sometimes ambiguous terms. Following FAO definitions (Food and Agricultural Organization of the United Nations (FAO), 2001), 'forests' exist when the canopy provided by trees covers at least 10% of an area, so both old and young stands of trees would count as

[1]The role of new agricultural technologies in forest transitions is difficult to discern. New agricultural technologies raise productivity to the point where the increase in harvests depresses the prices of crops which in turn makes it unprofitable for farmers to continue to cultivate marginal lands. In this illustration, increases in agricultural productivity decrease the area in agriculture. New agricultural technologies, by increasing productivity per hectare, will also raise the crop yield from a hectare which would encourage some farmers to expand the amount of acreage that they have under cultivation. For a fuller discussion of these offsetting effects, see Angelsen and Kaimowitz (2001).

forests. Forest transitions concern long-term changes in the extent of forests, not the short-term, cyclical changes in forest cover that occur when, for example, shifting cultivators clear land and then abandon it several years later. 'Deforestation' takes place when people clear land of trees and regrowth does not occur. 'Forestation' refers to a general process in which forest cover increases. 'Afforestation' occurs when forest cover expands through the planting of trees on lands without trees. 'Reforestation' occurs when forests spontaneously regenerate on previously forested lands.

Forest transitions occur at various scales; they may characterize a sub-region within a country, an entire country, or several countries within a large geographical region. While a forest transition may lessen the local environmental impact of a population, the total impact of these people on forested lands may actually increase if they begin to import substantial amounts of wood products and agricultural commodities from distant lands. Regions that export agricultural products are just as likely to experience a forest transition as regions that produce food for consumption in nearby cities. For example, the American South, heavily involved in the international trade in cotton during the 19th century, underwent widespread reversion to forest during the 20th century (Rudel and Fu, 1996).

4. Data: issues of validity and reliability

We use data from the Forestry Division of FAO (Food and Agricultural Organization of the United Nations (FAO), 2001) to carry out the following analyses. Several characteristics of the FAO data make them appropriate for use in historical analyses of changes in forest cover. Beginning in 1948, FAO foresters have periodically requested national level estimates of recent forest cover trends from experts in each member country.[2] FAO analysts have then compiled and published these data in a series of reports. In response to the growing concern with trends in tropical forest cover, FAO's foresters began providing much more detailed forest resource assessments in 1980. Several features of the most recent FAO survey, the FRA2000, make these data appropriate for the study of forest transitions. First, while two other groups have recently published global scale estimates of forest cover change arrived at through analyses of satellite imagery (Achard et al., 2002; Defries et al., 2002), only FAO provides national level estimates. Because the political and economic drivers of forest transitions vary to a great degree between nations, the national scale of measurement in the FAO data makes them more useful than the other data sets for investigating forest transitions. FAO's foresters produce estimates of forest cover change that lump together trends in natural forests with trends in planted forests. While this feature makes it more difficult to use the FRA data to understand trends in tropical biodiversity (Mathews, 2001), it makes it easier to analyze forest transitions because they usually involve changes in planted as well as naturally regenerating forests.

While researchers have made frequent use of the FAO data, they have also pointed out weaknesses in it, in particular its uneven quality and its inconsistent definitions across nations. The wealthier and larger countries have produced more reliable estimates based on analyses of field surveys or satellite imagery while smaller and poorer countries have relied on extrapolations from outdated surveys or other dubious estimation techniques. Since 1980, as more countries have relied on analyses of satellite imagery for their estimates, the overall quality of the FAO data has improved (Downton, 1995).

Until the 1990s the unevenness in the quality of the data was compounded by differences in FAO's definition of what constitutes a forest. To qualify as a 'forest', trees had to cover 20% of a piece of land in developed countries but only 10% of a piece of land in developing countries. To achieve more consistency, FAO adopted the 10% definition of forests for all countries in their 2000 survey. Using the new definition, dry, open woodlands that would not have been forests in the 1990 survey became forests in the 2000 survey. To produce credible estimates of forest cover change during the 1990s, FAO then went back and re-estimated 1990 forest areas using the new definition. This change in definitions led to some substantial increases in forest areas in 1990 in Australia and Russia. The recalculated estimates for 1990 forest areas were then used, along with the estimates for forest areas in 2000, to calculate trends in forest cover for the 1990–2000 decade (Food and Agricultural Organization of the United Nations (FAO), 2001; pp. 10–11). While these changes in definitions raise questions about the validity of FAO's data, the national level estimates, the time series, and the improved measurement procedures make it the best available source of information for investigating historical trends in forest cover across nations. We use these data to assess the forms that forest transitions take.

5. The historical features of forest transitions

Fig. 1 depicts two important features of forest transitions. First, the average decline in the proportion of forested land in a place during the first phase (from the origin to T1 in Fig. 1) exceeds the subsequent recovery in the proportion of forested land during the

[2] FAO's earlier assessments of the world's forest resources were published in 1948, 1953, 1958, 1963, 1981 and 1992.

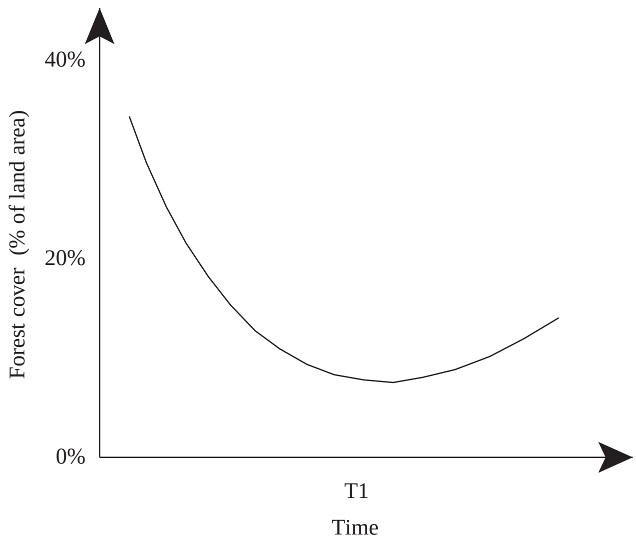

Fig. 1. The forest transition.

later phase by a ratio of approximately 2 to 1. This ratio of losses to gains characterized national forest cover trends between 1948 and 1990 in all of the countries that reported to FAO during that period (Rudel, 1998).[3] Second, the point of inflection, T1 in Fig. 1, where gains in secondary forests finally begin to exceed losses in old growth forests often does not occur until the amount of old growth forest has fallen to very low levels.

Fig. 2 plots the percentage of land in forests at the date of the turnaround for 20 countries with reliable data.[4] The turning points described here have all

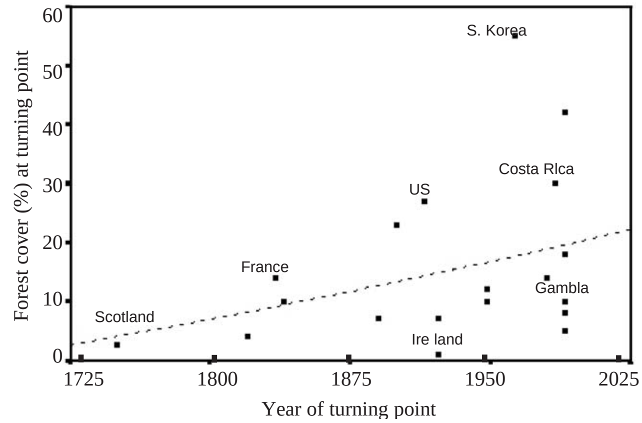

Fig. 2. Forest cover at the turning point.

occurred in the past 200 years, after the onset of industrialization. Earlier turning points undoubtedly occurred before the modern era. For example, many European countries experienced a reversion of recently deforested lands to forest after the Black Death in the mid-14th century (Herlihy, 1997; Poos, 1991). In the modern era forest cover declined to 3% of the land area in Scotland, 4% in Denmark, and 7% in China before turnarounds occurred. Conversely, New Zealand, South Korea, and the United States had comparatively large areas still in forest when turnarounds occurred. As the regression line running through the scatterplot in Fig. 2 suggests, turning points in the second half of the 20th century occurred with larger amounts of forest still standing. The range in the amounts of remaining forest also increased. These trends reflect to some degree an increased variability in the physical settings of forest transitions as they began to occur outside of Europe.[5] The trends also reflect changes during the 20th century in the social, economic, and political forces driving the transitions. The growth of cities pulled people off of the land more rapidly than it did during earlier periods, and nations like China undertook unprecedented planting programs (Rozelle et al., 2000; Zhang et al., 2000).

While forest transitions have occurred in a growing number of countries, they are not inevitable. The conditions under which they occur vary from place to place, and in some places they have not occurred at all. The forest transition accurately describes the dynamics of forest cover change in northern Europe between 1850 and 1980, but until recently it has not described historical trends in forest cover in southern Europe (Mather, 1990; McNeill, 1992). A combination of changing bio-physical and socio-economic conditions in the Mediterranean basin over a period of centuries contributed to gradual declines in forest cover

[3]The 2:1 ratio refers to the average percentage loss of forest cover during sustained periods of deforestation in countries compared with the average percentage gain in forest cover in countries experiencing sustained periods of forest recovery. Because the countries experiencing deforestation tend to have larger forests than the countries experiencing forestation, a worldwide ratio of forested hectares lost to forested hectares gained will be greater than the 2:1 ratio of percentage gains to losses in forest cover across nations.

[4]The 20 countries for which we have reliable estimates of forest cover when the turnaround occurred are as follows: Bangladesh, China, Costa Rica, Cuba, Denmark, Dominican Republic, France, Gambia, Hungary, Ireland, Peninsular Malaysia, Morocco, New Zealand, Portugal, Puerto Rico, Rwanda, Scotland, South Korea, Switzerland, and the United States. The estimate for the turning point in Switzerland may err on the high side because it represents forest cover at the date when governments began to collect data on forest area in the mid-19th century. For Denmark, France, Portugal, and Switzerland the data come from historical studies reported by Mather and Needle (1999). The data for most of the countries with more recent turning points came from FAO. The sources for the other countries are as follows: China—R. Zon, W. Sparhawk, (1923) *Forest Resources of the World* (McGraw-Hill, New York); Costa Rica—C. Kleinn, L. Corrales, and D. Morales (2002) *Environ. Monit. Assess.* **73**, 17; Ireland—Gillmor in (1993) *Afforestation* A. Mather, ed. (Bellhaven, London), 34; New Zealand—M. Roche, R. Le Heron in *Afforestation,* op. cit., 142; Peninsular Malaysia—H. Brookfield (1994) in *Transformation with Industrialization in Peninsular Malaysia* H. Brookfield ed. (Oxford, Kuala Lumpur, 77); Scotland—A. Mather in *Afforestation*, op. cit., 15; United States—M. Clawson (1979), *Science* **204**, 1168.

[5]The increase in the range of turnaround points reflects the increased number of documented turnarounds in forest cover trends in recent years compared to earlier historical periods.

with no recovery until the last three decades of the 20th century.

5.1. Two types of transitions during the 1990s

Analyses of data from FAO's recently released Forest Resource Assessment 2000 illustrate the contingent, conjunctural nature of forest transitions. During the 1990s 38% of the world's countries experienced increases in forest cover, and a large number of these countries, after earlier periods of deforestation, had begun to experience sustained increases in forest cover. The circumstances surrounding these transitions have varied across nations. At the risk of simplifying the complex political economies that drive forest cover change in different countries, we have grouped together nations that illustrate different trajectories of forest cover change in Table 1.

The trajectories in the first two groups conform to the forest transition idea. The first panel characterizes European societies, and the second panel characterizes Asian societies. While northern European countries experienced increases in forest cover throughout the 20th century, the spread of forests has only recently accelerated in the more peripheral European nations grouped in panel (1) of Table 1. This shift coincided with changes in the agricultural economies of these nations. The expansion of the European Common Market during the 1970s and 1980s stimulated rapid economic growth in the recently admitted, low wage countries on the European periphery. The resulting growth in non-farm employment pulled labor off of the land and encouraged landowners to save on agricultural labor by converting some of their fields into forests (Bentley, 1989). Because labor scarcity rather than forest product scarcity drives the conversion to forests in the economic development path to the forest transition, the countries in panel (1) tend to have more forest per capita than other countries when the turnaround in forest cover trends occurs.

Quite a different pattern of forest cover change has unfolded in the past 15 years in the East and South Asian countries grouped in panel (2) of Table 1. Although rural populations remain very poor, the continued decline in the extent of forests, coupled with economic growth in urban areas, increased the prices of forest products and raised concerns about the continued availability of wood products (Foster and Rosenzweig, 2003). Government officials responded to the growing scarcity of wood, and in some cases to disastrous floods in deforested watersheds, by initiating forestation programs. These programs took distinct forms in different countries. The central government in China, through its Upland Conversion Program, provided the impetus, organization, and funds to establish extensive tree plantations (Fang et al., 2001; Rozelle et al., 2000; Zhang et al., 2000). In India, village committees increased their efforts to expand and restore small,

Table 1
Trajectories of forest cover change; data source: FRA2000 at www.fao.org/forestry/fo/fra/main

	Land area in forest, 2000 (%)	Forest area per capita, 2000 (in hectares)	Annual forest cover change, 1990–2000 (%)
(1) Afforestation induced by labor scarcities			
Greece	27.9	0.3	+0.9
Ireland	9.6	0.2	+3
Portugal	40.1	0.4	+1.7
(2) Afforestation attributable to scarcity of forest products			
Bangladesh	10.2	<.1	+1.3
China	17.5	0.1	+1.2
India	21.6	0.1	+0.1
(3) Deforestation attributable to poverty traps			
Ethiopia	4.2	0.1	−0.8
Haiti	3.2	<.1	−5.7
Togo	9.4	0.1	−3.4
(4)Deforestation induced by war			
Burundi	3.7	<.1	−9
El Salvador	5.8	<.1	−4.6
Rwanda	12.4	<.1	−3.9
Sierra Leone	14.7	0.2	−2.9
(5)Deforestation attributable to expanding markets in large forests			
Brazil	64.3	3.2	−0.4
Cameroon	51.3	1.6	−0.9
Indonesia	58	0.5	−1.2

degraded community forests after the government approved joint forest management schemes that in effect devolved control over forests to local communities (Singh, 2002; Foster and Rosenzweig, 2003). Both countries exemplify the forest scarcity path to the forest transition. The rough geographical groupings evident in (1) and (2) indicate that trajectories of forest cover change often extend across entire regions, reflecting common underlying socio-economic and biophysical conditions.

The trajectories of forest cover change do not always take the general form of a forest transition, even when woodlands become very scarce. Panels (3)–(5) of Table 1 describe historical situations in which earlier forest declines have not triggered later forest recoveries. In the countries grouped in panel (3), farmers usually could not find employment outside of agriculture. Without institutions to provide technology, capital, or access to markets, farmers could not improve land productivity, so they have to expand the areas under cultivation to secure their livelihoods. These economic circumstances 'trapped' farmers into converting the last forests in a region into fields (McPeak and Barrett, 2001).

In the countries grouped in panel (4) civil wars have caused changes in forest cover that do not conform to the sequence of events in a forest transition. Collective violence has affected primary and secondary forests differently. The sharp declines in forest cover reported in panel (4) come from old growth forests. The collapse of civil authority has made some formerly protected old growth forests vulnerable to invasions. In some instances the contending parties have cut down old growth forests to raise money for their causes or to reduce cover for their adversaries. At the same time, the violence, by depopulating rural places, has encouraged the emergence of secondary forests and scrub growth on abandoned fields (Kaimowitz and Faune, 2003).

Panel (5) describes trends in the forest rich tropical countries of Brazil, Cameroon, and Indonesia that contain much of the world's biodiversity. During the 1990s forest transitions did not take place in these countries. Political elites continued to regard old growth forests as an endless source of potential wealth, and these perceptions prevented the implementation of forest conserving policies, so net forest area continued to decline. Secondary forests, sometimes planted, have recently increased on the cutover and burned tracts of land in the three countries, but these increases have only partially offset the continued decline in old growth forests. While forest cover trends in small areas like the coastal regions of southern Brazil show signs of incipient forest transitions (Caruso, 1990), it seems unlikely that in the near future a forest transition will save the large repositories of biodiversity in the three countries.

5.2. Global patterns during the 1990s

Statistical analyses of forest cover trends during the 1990s in 139 countries in the FRA2000 reveal a pattern of forest transitions that is consistent with the trajectories described in panels (1) and (2) of Table 1.[6] Nations with increasing forest cover, many of which have begun to experience the forest transition, and nations with declining forest cover, most of which have not experienced a forest transition, differ from one another in both per capita income and the extent of forest cover. Nations that gained forest cover during the 1990s had an average GNP per capita of \$8453 in 1990 compared with \$1614 among nations that lost forest cover ($p = .001$). Poor and middle income nations (GNP per capita < \$11,000) that gained forest cover during the decade had 25.3% of their lands in forest compared with 34.3% in nations that lost forest ($p = .05$). This last difference suggests that, in line with the findings in panel (2) of Table 1, some forest transitions have occurred in lower income countries when forests became scarce and governments implemented forestation programs.

Table 2 presents logistic regressions in which we regress whether or not a nation gained forest cover during the 1990s on indicators of the two types of forest transitions. The indicator for the economic development path to the transition is GNP per capita in 1990. The indicator for the forest scarcity path is the percent of land in forests in 1990. According to the line of argument developed earlier, each variable should explain substantial amounts of variation across nations in forest cover change during the 1990s.

The correlation between the two independent variables is low (.028), so the equations in columns (2)–(4), do not suffer from colinearity problems. The results from these equations provide further support for the findings from the bivariate analyses presented above. When the extent of forest cover is added to per capita income as a predictor, the increment in the percentage of cases predicted correctly increases from 60.3% in column (1) to 75.7% in column (2). This finding indicates that a scarcity of forests prompts forest transitions in a distinct set of countries. It suggests the utility of thinking about two paths through the forest transition, one driven in part by labor scarcities in more affluent nations and another prompted in part by forest product scarcities in poorer nations.

An alternative way to investigate the existence of the two paths through the forest transition would be to sort the nations that we expect to exhibit different paths into

[6] Unlike most cross-national studies which include between 50 and 100 carefully selected countries, this study tries to avoid selection bias by including all 139 countries for which FAO has collected data. The study still excludes some countries, almost all of them being small island states that do not collect forest cover data.

Table 2
Logistic regressions on the characteristics of nations undergoing forest transitions

Variables	(1) World	(2) World	(3) Europe/Americas/Oceania	(4) Asia/Africa
(1) GNP per capita, 1990	.23*** (.06)	.23*** (.06)	.206*** (.06)	.334*(.143)
(2) Forests as % of land area, 1990		−.023* (.011)	.001 (.016)	−.045** (.017)
N of cases	136	136	58	78
% of cases predicted correctly	60.3	75.7	77.6	78.2
Pseudo r2	0.243	0.273	0.303	0.223

Source: FAO statistics at www.fao.org/forestry; $* = p<.05$, $** = p<.01$, $*** = p<.001$. N.B. The numbers in rows 1 and 2 are unstandardized regression coefficients. The standard error of each coefficient is in parentheses beneath the coefficient.

separate groups. After estimating equations for net forestation for each group of nations, we could compare the coefficients from the two equations to see if they differ significantly from one another. If they do, this finding would strengthen the empirical case for the existence of several different paths through the forest transition. We present this type of analysis in columns (3) and (4) of Table 2. Drawing on the geographical clusters evident in panels (1) and (2) of Table 1, we have sorted nations into a poorer African–Asian cluster of nations where we would expect forest scarcity to drive the transition and a wealthier European–American cluster of nations where we would expect economic development to drive the transition.

The coefficients of our two indicator variables differ in expected ways between the two regions. The extent of forest cover explains little variation among the more affluent European and American nations. It explains more variation than the affluence variable among the poorer African and Asian nations. Along with the increments in cases predicted correctly in column (2), the geographical clustering of these patterns of association in columns (3) and (4) suggests the existence of two types of forest transitions.

The addition of urbanization measures to these equations does not strengthen their explanatory power, so we do not report these results here.[7] Data for other potentially important variables, like the incidence of corruption in government forestry programs, do not exist for many nations, so we could not integrate these variables into the multivariate analyses without altering the set of nations under analysis in substantial ways. We may, however, be able to advance this line of argument in a suggestive way through additional bivariate analyses. Even when forests become scarce, forest transitions may not occur unless governments can create effective forestation programs (Mather and Needle, 1999). The close association (.355, $p = .006$) in poor countries between forest recovery and a low perceived level of corruption suggests a link between governance and forest recovery (Palo, 2002).[8] Forestation will not occur unless governments can implement their plans, and implementation depends crucially on the incidence of political corruption in a society. Where governments are more corrupt, tree planting programs often fail. This point underscores the conjunctural nature of the conditions that underlie the forest transition. While labor scarcity in one place and forest product scarcity in another place may induce the conversion of fields into forests, policymakers usually play crucial supporting roles, especially in poor countries where government programs foster forest transitions.

Although derived from the empirical findings presented here, the arguments outlined above remain somewhat speculative because their empirical bases are weak. The relatively low amount of variation explained in the equations in Table 2, the incomplete data sets for important variables like the incidence of corruption, and the short time series of observations about forest cover change all argue for more exhaustive studies of the ecological and socio-economic conditions that foster forest transitions.

6. Conclusion: can governments expedite transitions?

Any attempt to derive policy implications from the preceding analysis must begin by acknowledging the need for further research to confirm the existence of the two types of forest transitions outlined above. Policymakers will not, however, wait patiently for the results of sustainability science, so, with policymakers in mind, we spell out below the implications of our findings for forest policy. One question seems especially important. Given the potential of forest transitions for slowing soil erosion, improving water quality, and slowing climate change through carbon sequestration, can governments speed the transitions up, or, once they have begun, insure that the transitions continue?[9] The authors of the

[7]These results are available from the first author upon request.

[8]For a general discussion of the effects of corruption on forests, see Kaimowitz (2003).

[9]As the last phrase of the sentence implies, forestation does not continue indefinitely once it has begun. For example, the expansion of residential areas into forests outside of central cities (sprawl) has caused significant forest losses in the eastern United States (McDonald and Rudel, 2005).

Kyoto Protocol think so. By establishing economic incentives for carbon sequestration, the Kyoto conferees provided a political-economic impetus for forestation in all countries.

Foresters in national governments might find that the effectiveness of policies varies with the size of the forests in their country. In countries with few forests that follow the forest scarcity path, government officials would want to promote tree planting. Government tree plantations have frequently suffered from low rates of seedling survival (Persson, 1996), but recently programs of plantation expansion have become more effective when government foresters have enlisted non-governmental organizations to facilitate plantings (Brechin, 1997) and given local residents incentives for guarding plantations (Mukherjee, 1997). During the past two decades governments in China, through the expansion of publicly owned tree plantations, and governments in India, through the devolution of control over small plantation forests to villages, have promoted forest recoveries.

In forest rich countries governments might want to pursue the economic development path to the forest transition. In this sequence of events forests would not decline to a small area before recovery begins because shortages of agricultural workers would prevent further agricultural expansion. Rising farm labor prices would make it more costly to engage in labor intensive agriculture on marginal lands and encourage farmers to make a less labor intensive use of these lands, like forests. The connection between any single government policy and the increased absorption of farm labor into the non-farm sector may, however, be too tenuous to conclude that governments could accomplish this end and promote forestation through changes in labor policies.

Generally, governments can be most effective in promoting forest transitions when forest expansion policies build on pre-existing economic trends like the increasing scarcity of timber in countries with few forests or the growing demand for off-farm labor in forest rich countries with rapidly growing urban economies.

Acknowledgements

Two workshops sponsored in 2002 by the Land Use and Cover Change (LUCC) project of the International Geosphere–Biosphere Programme and the International Human Dimensions Programme facilitated this work. "Linking Causes, Drivers, and Pathways with Rates and Patterns of Land Change" took place in Louvain la Neuve, Belgium, 11–13 April 2002 and "Causes and Drivers of Land Use Change in Latin America" took place in Tempe, Arizona, November 14–16, 2002. We thank the participants and sponsors of these workshops for the opportunity to develop these ideas. We would also like to thank J. Arnold and D. Kaimowitz for comments on an earlier draft of this paper.

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