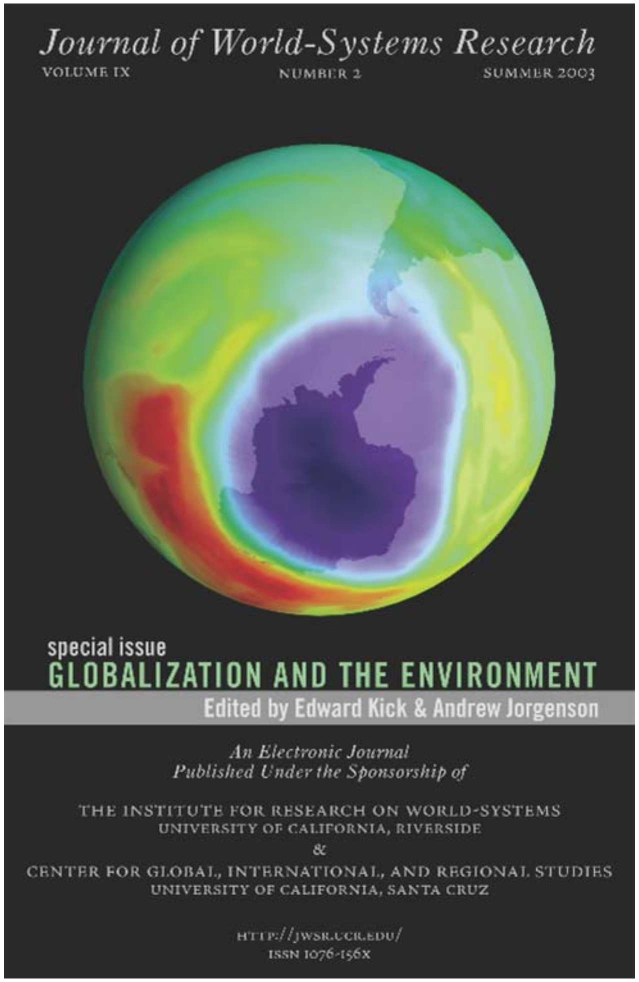

ABSTRACT

Building on prior work in world-system analysis and human ecology, we test a macro-level theory that social and demographic causes of deforestation will vary across zones of the modern world-system. Using multivariate regression analysis, we examine models of deforestation over the period 1990-2000. We test for main effects of world-system position, two different population variables (urbanization and proportion under working age), and economic development within zone, as well as for the contextual effects of these variables as they operate differently across world-system positions. Our findings indicate that generic models of deforestation need to be qualified, because the particular social factors most closely associated with deforestation tend to vary by position in the global hierarchy. Deforestation at the macro level is best explained by considering effects of socio-demographic processes contextually, in terms of world-system dynamics. We discuss the findings in a more general world-systems and behavioral ecological framework, and suggest the field will be well served with more precise theorizing and closer attention to scope conditions.

Theorizing and Rethinking Linkages Between the Natural Environment and the Modern World-System: Deforestation in the Late 20th Century*

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INTRODUCTION

In tracing world ecological degradation over a period of five millennia, Sing Chew (2001) points out that "…the history of civilizations…and states is also the history of ecological degradation and crisis…[as such]…ecological relation is as primary as the economic relation in the self-expansionary processes of societal systems…" (pp. 1–2). Particularly over the last half of the twentieth century with its expanding global markets, there has been a dramatic upsurge in the rate at which deforestation is occurring (Chew 2001:141 ff.; also see Noble and Dirzo 1997).

While deforestation is a worldwide problem, prior research indicates that the rate of deforestation, as well as its causes, tends to vary markedly by a country's position in the world-system (Burns et al. 1994; Kick et al. 1996). Thus, while the history of the modern world is replete with illustrations of the ecologically destructive nature of geographic expansion of the system (Moore 2000; Smith

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1994; Tarr 1991), it is important to note that where a nation stands in the modern global hierarchy, and the national characteristics stemming from it, influence the proximal causes, amounts and types of environmental degradation it experiences (Colinvaux 1980; Ponting 1991).

In an increasingly globalized world economy, national inequalities continue to manifest themselves in a stark fashion. Wallerstein (1974, 1979, 1984, 2003) has argued that the current capitalist world-economy or world-system, which emerged in the 16th Century and continues to evolve, is characterized by a global division of labor, as well as exploitation and unequal exchange that has generated and maintained a relative structural inequality across core, semiperipheral and peripheral "zones" of the world-economy.

This general view has been expanded upon extensively, and we do not replicate that discussion here. Rather, we refer the reader to a number of works elaborating this perspective (Chase-Dunn 1998; Chase-Dunn and Hall 1997b; So 1990; Frank 1979 & 1980; Kentor 2000; Snyder and Kick 1979; Kick et al. 1995 & 1998; Bollen 1983; Modelski and Thompson 1996; Terlouw 1993). Researchers have empirically examined the impacts of these unequal global relationships on various national level outcomes. Examples of these, among many others, include economic growth (Chase-Dunn 1975, Bornschier and Chase-Dunn 1985, Rubinson and Holtzman 1981, Kentor 1998; Kentor and Boswell 2003), and urbanization (Timberlake and Kentor 1983; Kentor 1981; Smith 1996, 2003, London and Smith 1988, Taylor 2003).

Within the past decade, there also has been a growing interest in attempting to understand environmental problems in a world-system framework. A number of cross-national studies have been done from the world-system perspective that shed light on problems such as greenhouse gas emissions (Roberts and Grimes 1997, 1999, 2002; Burns et al. 1997, 2001); international patterns of accumulation and transfer of hazardous waste (Frey 1995, 1998, 2002); the ecological footprint (Jorgenson 2003; also see Jorgenson and Burns 2003; York, Rosa and Dietz 2003); as well as studies of deforestation (Burns et al. 1994, 1998; Kick et al. 1996; for earlier case studies see Bunker 1984, 1985). In this study, we build on and expand prior work, in order to understand more clearly the worldwide problem of deforestation, particularly as it has taken place in the modern era.

THE WORLD-SYSTEM AND ENVIRONMENTAL CONSEQUENCES

We examine relationships between the world-system position of nations, their national attributes and their consequent environmental profiles. We theorize that due to world-system impacts, national deforestation rates will vary cross-nationally in systematic ways. While these impacts are witnessed directly, they also are manifested indirectly via national institutions, and demographic as well as geographic dynamics. The causal forces we specify culminate in interpretably different deforestation consequences for core, semicore, semiperiphery and periphery nations. Our specification is informed by a range of case studies (e.g. Bunker 1984, 1985), and quantitative cross-national efforts (e.g. Burns et al. 1994, 1997, 1998, 2003; Kick et al. 1995, 1996; Rudel 1989; Roberts and Grimes 1997; Ehrhardt-Martinez 1998, 1999; Ehrhardt-Martinez et al. 2002), that *when taken together* permit the formation of a more coherent approach to the linkages among international dynamics, national properties, and deforestation consequences.

Our theoretical formulations and analyses respond in part to prior work in the area that does not consider the full range of world-system or dependency processes. Ehrhardt-Martinez (1998, 1999), for example, sees a theoretical vacuum in this area. While her work does include a world-system/dependency variable, it does not adequately test for a range of world-system dynamics, despite evidence from prior work (e.g. Kick et al. 1996) that these dynamics, including *interactions* between the world-system and domestic processes, have significant power in explaining national variation in environmental degradation—particularly deforestation.

An additional and related limitation of much of the work in this area is the examination of forest change in developing societies only (see Ehrhardt-Martinez 1998, 1999; Allen and Barnes 1985; Rudel 1989; Rudel and Roper 1997). While developing societies clearly are crucial areas of concern, it is also important to consider the fragile nature of boreal forests, and the state of temperate forests (Chew 2001:150 ff.), many if not most of which are in what could be considered core or semicore countries. Additionally, a number of macro-level social processes are likely to emerge from empirical cross-national research only when considering the world as a whole, rather than limiting the focus to one part of it (see Tilly 1984).

Due to their respective positions in the world-system, core countries tend to be the most technologically and economically advanced in the world. Also, because of natural geographic as well as the economic and political advantages stemming from their relative position in the global hierarchy, huge amounts of resources are available to countries of the core (Fain et al. 1996/1997; Lenski and Nolan 1984). These dynamics are no small consideration when analyzing changes in the world's forest cover. It bears noting that about half of the world's forests are located in industrialized countries of the core or the semicore (WRI 1994: 135). When the technology and wealth of core countries are coupled with their abundant forests, a far greater physical opportunity to deforest and to *re*forest is provided than for the other zones (Burns et al. 1994; also see Rudel 1998). Thus, the increased efficiencies of core production, and alternative resources available to them, may in some cases help to facilitate favorable forestation consequences there.

Further, as prior work on the world wood trade indicates, at least some of the deforestation in the periphery and especially in the semiperiphery, is attributable to world system dynamics that favor core or semicore countries (Kick et al. 1996). One of the primary stimuli to industrializing economies is their export market. The natural and animal resources of the non-core, such as forests and cattle, represent such prime commodities for export. One would expect such exports to generate deforestation in semicore and semiperipheral countries, just as they do in the periphery[1] (Lang 2002; Behrens 1994; Sierra and Stallings 1998).

The industrializing countries of the semicore and semiperiphery are potentially upwardly mobile in the world system (So 1990; Wallerstein 1979; Arrighi and Drangel 1986; Terlouw 1993; Burns et al. 1997), and as a result, are in many respects undergoing more rapid change than either peripheral or core nations. Prior research has suggested that the dynamics of this process, particularly economic growth, expands the availability of capital for a range of activities that can exploit domestic resources (Rudel 1989).

A series of findings from prior work in fact indicate that in terms of at least some outcomes and at some time periods, environmental degradation is most severe in the industrializing countries of the semiperiphery (Burns et al. 1994; Kick et al. 1996; Roberts and Grimes 1997) or the semicore (Burns et al. 1997)– that is, in the middle ranges of the world-system hierarchy rather than at either the high or low end. This has led some researchers to refer to an environmental "Kuznets" effect (c.f. Kuznets 1955), in which there is a non-linear relationship between development variables such as urbanization or economic growth, and environmental degradation (e.g. Burns et al. 1994, 1997, 1998; Bergesen and Bartley 2000; Kick et al. 1996; Roberts and Grimes 1997; Ehrhardt-Martinez 1998, 1999; Ehrhardt-Martinez et al. 2002; York, Rosa and Dietz 2003).

Yet it is important to point out that some dynamics may follow a linear relationship while others may not. For example, Burns et al. (1997) in a study linking greenhouse gas emissions with world-system processes, found that position in the world-system hierarchy was linearly related with national emissions of one

1. As a number of researchers have pointed out (e.g. Guess 1979, 1991; Hecht 1985), much of the deforestation in developing countries is attributable to land-clearing for the purpose of livestock ranching. Much of the meat from the eventual slaughter of the livestock is then exported to more developed countries.

greenhouse gas (CO_2), while emissions of another greenhouse gas (methane) tended to be heaviest in semicore countries.

Prior work on deforestation (Burns et al. 1994) finds that for the period from 1965 to circa 1990, deforestation was indeed more severe in the semiperiphery than in either the periphery or the core. This effect, at least in terms of forest change dynamics, may be attributable in part to reforestation programs in the core and, to a lesser extent, in parts of the semicore.

It is worth considering that the lower rates of deforestation in the periphery than in the semiperiphery may have been an historical artifact. Peripheral countries continue to experience the greatest population growth, which puts a strain on resources of all sorts. Further, while peripheral countries are the least urbanized, many of them are urbanizing rapidly, as they are increasingly drawn into the dynamics of the world system.

Yet the semiperiphery has been in a trajectory of urbanization longer than has the periphery. In fact, much of the urbanization of the semiperiphery is likely connected with the increasing incorporation into the world-system and its export-based economies. Also, the increasing consumption associated with the modernization process is likely to be catalyzed by urbanization there.

Ironically, the overdevelopment of urban areas and the social dislocation associated with it, often precipitates encroachment into forested regions (see Burns et al. 1994; Postel and Ryan 1991; Anderson 1990). This "rural encroachment" (Burns et al. 1994), coupled with other in-migration patterns, such as refugee migration (Homer-Dixon 1994, 1999; Guess 1979; Schmink and Wood 1992) often results in forested regions' eventual "development" into agricultural or even industrial usage (Koop and Tole 1997; Rudel 1998 & 1989). Some developing countries have even instituted policies promoting migration to such areas (Miller et al. 1991; Guess 1991) (e.g. to foster national defense goals, despite the fact that development in forested areas for agricultural or other uses has been directly linked to environmental degradation in general, and deforestation in particular) (Anderson 1990; Nazmi 1991). A vast proportion of out-migrants from urban to rural areas in the periphery of the world-system additionally tend to be relatively poor, unskilled and undereducated, and thus have little to hold them in the cities. This combination has been shown to be associated with a number of aspects of environmental degradation (Ghimire 1994; Niang 1990).

Perhaps more alarming is recent work that has begun to describe a process in which technological diffusion leads to increasing "efficiencies" of logging and other deforesting practices. An increasing worldwide awareness of an impending shortage of forest products may tend to increase demand for wood from any source. These are accompanied by other shifting constraints in the world economy such as lowered shipping and transportation costs, as worldwide exchange practices move increasingly in the direction of "free trade" particularly the variety championed by the World Trade Organization (e.g. Fink et al. 2002; also see Cukrowski and Fischer 2000; Leonard 1988). The widening gap in environmental regulation between the consuming countries of the core and the lack of it, particularly in the periphery, shifts capital's cost/benefit ratio in the direction of a number of environmentally devastating practices toward the periphery (e.g. Xing and Colstad 2002; Mitchell and Cutter 1997; Bello 1992). There is, moreover, a continuing tendency to externalize environmental costs (e.g. Steininger 2001).

The changing face of the logging industry is worth noting as well. It is becoming increasingly common for a company based in, for example, a semiperipheral country such as Indonesia, to sponsor logging efforts in other semiperipheral or peripheral countries. The combination of aforementioned factors may make it "cost effective" for the exploitation of resources from a South Asian or perhaps East African country.

For lack of a better term, we might refer to this pattern as "recursive exploitation," in which a nation in the semicore or semiperiphery is at a disadvantage to one in the core, yet is able to work exchanges in its favor when they involve the semiperiphery or periphery. This would include practices such as those we have just described, in which, for example, a semiperiphery-based company extracts resources from a weaker country in the same tier, or a lower tier, than itself. While historically there has been somewhat of a "regional bias" in international trade (Ludema 2002), what could be considered a region may itself be enlarging with increasing economies of scale, decreasing shipping costs and favorable trade conditions (Jovanovic 2003).

Thus, changing (and in many ways worsening) worldwide economic conditions and external capital investments may drive significant cutting of peripheral forests (Ambrose-Oji et al. 2002). While the magnitude of deforestation in the periphery has been relatively restricted by marginal technological development and somewhat circumscribed international trade linkages in the past (see Kick et al. 1996), the shifting balance may well be in the direction of even greater and more efficient exploitation of the natural resources of the periphery.

In addition to world-system processes, it is important to consider other explanatory variables that theorization and empirical research have indicated are key causal agents in deforestation. We consider particularly the effects of population and affluence within the context of human ecological theory. We then turn to questions about whether these factors are likely to *interact* with world-system processes, and what those interactions mean in terms of ecological degradation in general and deforestation in particular.

POPULATION DYNAMICS AND RELATIVE AFFLUENCE IN THE WORLD-SYSTEM

As Malthus (1798/1960) pointed out over two centuries ago, population is an important factor in the long-term survival of the planet (for more recent statements in this tradition, see Ehrlich 1968; Ehrlich and Ehrlich 1990, 1991; also see Cohen 1995). Increasing numbers of people using resources tend to have a cumulative impact on the environment (Hunter 2000; Preston 1996; WRI 2000). But even in this case, the human organizational environment of that population often makes a profound difference.

A commonly utilized theoretical framework consequently posits that population (P) interacts with affluence (A) and technology (T) to produce environmental impact (I) (Commoner 1972, 1992, 1994; Commoner, Corr and Stamler 1971; Ehrlich and Holdren 1970, 1971, 1972; Dietz and Rosa 1994; York, Rosa and Dietz 2002, 2003). As the "IPAT" model implicitly acknowledges, taking population in isolation misses the dynamics of the causes of environmental degradation, because the strain on resources varies so widely from one unit of population to another (for a detailed theoretical discussion see Dietz and Rosa 1994; also see Cohen 1995).

In our theorization, we draw on the IPAT model (and its "STIRPAT" variant used with stochastic regression models) (see Dietz and Rosa 1994; York, Rosa and Dietz 2003). Recent research in this framework finds that just two variables—(P)opulation of working-age adults, and (A)ffluence as measured in terms of GDP per capita—explain approximately 95% of the variance in a nation's macro-level consumption as measured by the "ecological footprint"[2]

[2] More specifically, the ecological footprint accounts for the consumption process itself, including forest resources (for discussions, see York, Rosa and Dietz 2003; Jorgenson 2003; Jorgenson and Burns 2003; Wackernagel et al. 2000; Wackernagel and Silverstein 2000; also see Bernstam 1990).

While it is difficult to know this definitively, it would appear that the micro- and meso-level causes of deforestation are likely to vary by world-system position also. For example, the periphery may have more slash-and-burn activity while in the semiperiphery (and perhaps the semicore), there may be more logging for commercial export (Kick et al. 1996). Gutelman (1989) estimates that slash-and-burn horticulture accounts for 70% of Africa's, 50 % of Asia's, and 35% of Latin America's deforestation. Differences among zones in the world-system appear to be seen as in terms of how environmental movement organizations and "greening" policies play themselves out as well. For discussions of international differences in approaches to environmental attitudes and discourse, see Dietz and Kalof (1992); also see Burns and LeMoyne (2001); and Perz (2002). The

(York, Rosa and Dietz 2003).[3] Those variables are robust across models controlling for alternative explanations from a wide array of theories, including political-economic, modernization, and human ecological perspectives (York, Rosa and Dietz 2003; also see Jorgenson 2003; for a detailed explanation of the rationale and measurement of the footprint itself, see Wackernagel et al. 2000, Wackernagel and Silverstein 2000; Wackernagel and Rees 1996).

Yet population *per se* does not explain a great deal about environmental degradation. Prescinding momentarily from the question of population's interaction with other IPAT variables (most notably, measures of affluence), we are still left with the question of what *aspect(s)* of population are most closely associated with environmental depletion. As prior work testing those ideas specifically has begun to show, *distributions* of the population (particularly in terms of age and geography) make profound differences in amounts and specific manifestations of environmental degradation (Burns et al. 1998). When we do put this together with other factors, the level and allocation of resource usage is largely a function of living standard, which in turn is associated with other factors such as levels, distributions and uses of technology in the society.

Consider, for example, a number of studies indicating that the usage of resources in cities is quite different from resource usage in rural areas (Smith 1994, 1996; also see Kasarda and Crenshaw 1991; Crenshaw and Jenkins 1996). As nation-states are incorporated into the world economy, they tend to have concomitant rises in urban populations (Smith 1996, 2003; Kentor 1981; Timberlake and Kentor 1983). Largely because international trade tends to take place through urban areas, this further draws urbanizing nation-states into the world-system (Taylor 2003), and so this cycle is self-reinforcing.

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broader point is that the causes, types and degrees of environmental problems differ dramatically in terms of where a country stands in the internationally hierarchy, as do ways in which people there think and communicate about them.

3. York, Rosa and Dietz (2003) do control for a non-linear (in this case, quadratic) effect of GDP per capita. Each of the other control variables is modeled only linearly. As in the case of Ehrhardt-Martinez (1998, 1999; Ehrhardt-Martinez et al. 2002) modeling social and demographic causes of deforestation, York et al. only model world-system position as a main effect. Yet as prior research on deforestation and other types of environmental degradation has shown both theoretically and substantively, world-system dynamics tend to have indirect and interactive effects (Burns et al. 1994, 1998, 2003; Kick et al. 1996).

Dramatic increases in urban populations put strains on resources as well, in that this giving rise to a "metabolic rift" in consumption patterns between urban and rural areas (Jorgenson 2003; Jorgenson and Burns 2003; Foster 1997, 1999, 2002; for case studies in Latin America see Stonich 1992, Mueller 1995, also see Bunker 1984 & 1985). As this occurs, large urban agglomerations put demand on resources for their own use and for export, while extraction of those resources tends to be from rural areas where there are still natural resources available (Meardon 2001; also see Smith 1994, 1996).

Significant amounts of deforestation are attributable to international trade in wood and wood products, although the specific ways in which a country experiences these dynamics are different depending upon its position in the world-system (Kick et al. 1996). This is part of a more general process in which the ability to garner resources in an unequal exchange varies with a society's position in the world economy (Amin 1974, 1976; Hornborg 1998, 2000; also see Alderson and Nielsen 1999; Landsberg 1979; London and Smith 1988; Modelski and Thompson 1996; O'Connor 1989; Podobnik 2002). This in turn likely has a profound effect upon its ability to consume resources from less affluent parts of the world while strengthening the chances of conserving its own resources.

Questions about age cohorts are crucial as well. Ecologists (e.g. Catton 1980, 1994; Fearnside 1984, 2000; Postel 1994) often refer to the *carrying capacity* of the natural environment. In analyzing plant or animal populations, carrying capacity is the number of a given species able to live indefinitely within its natural environment, given constraints on resources such as food and shelter. While a given population may live beyond its carrying capacity (sometimes referred to as "overshoot") for a relatively short period of time, it cannot do so indefinitely. That period tends to correspond closely with the reproductive time lag of the species in question, because the greatest strain on resources occurs when coming into adulthood (c.f. Pimentel et al. 1994). The consequences for the human species of these two aspects of behavioral ecological theory considered together—the potential for overshoot in conjunction with the reproductive time lag effect—are considerable: (1) the effects of overpopulation may not be fully experienced until some *significant time after* onset; and (2) the potential for ecological degradation is *not* spread evenly. *Ceteris paribus*, adults tend to put more strain on resources while children put relatively less strain on them–until they themselves come into reproductive age. In this paper, we specifically examine the relationship between the below-working age cohort and national change in forest cover. It bears remembering that *in the short run* corresponding to the period we test here, this is expected to be the *least* impactful of the cohorts.

THEORETICAL SUMMARY

We explore a number of alternative conceptions of the constructs in the impact model. The permutations we develop are driven by different demographic and social dynamics, examined both linearly and interactively with world-system processes. In particular, we pay close attention to the question of *what about* population is impactful. To inform our analysis, we borrow several ideas from behavioral ecology, demography and macro-sociology, but which could bear further development in the environmental sociology literature.[4]

In summary, then, we expect the particular social factors most closely associated with deforestation will tend to vary by world-system position. We also theorize about population dynamics, particularly in terms of the relative *distribution*s between urban and non-urban areas, and between working-age and below-working age people. We expect that with increasing urbanization, resource depletion *per unit of population* increases as well; consistent with our earlier theorization, we also expect the effects of urbanization will vary across world-system position. Likewise, we expect that effects of population age cohorts will also vary by zone in the world-system.

METHODOLOGY

Country Sample

Following conventional practices in this research area, our sample includes all countries of the world for which data were available on all independent and dependent variables modeled. Preliminary regression analyses showed Oman was a statistical outlier, based on its standardized residual (> 8.0), the Mahalanobis distance score (largest relative value), and its Cook's D value (> 4.0). With the omission of Oman the sample is comprised of 73 nations (for in-depth discussion of effects of influential outliers, see Bollen and Jackman 1985). The final sample includes 10 core, 11 semicore, 36 semiperipheral, and 16 peripheral countries.

4. While world-system analysis is central to the framework of our study, we recognize the importance of related works on the environment in other scientific fields (e.g. Pimentel et al. 1994; Ricklefs 1973; Colinvaux 1980; Nilsson and Shivdenko 1997; Hinde 1974; Miller 1969; Gause 1934; Grossman and Krueger 1995; Beckerman 1992; Noble and Dirzo 1997; Fleming 1996; Allen and Barnes 1985; Behrens et al. 1994). Researchers seeking to understand the complexities of these processes would do well to incorporate at least some of these literatures into their theorization.

We identify the structural position of countries in the world system using Kick's classification (1987; also see Snyder and Kick 1979). Detailed discussions of alternative operationalizations of the world system appear elsewhere and we do not attempt to recreate those discussions here (see Burns et al. 1997, or Kentor 2000 for summaries of the strengths and weaknesses of alternative schemas). Appendix A reproduces this classification for countries used in our analyses.

Outcome Variable

Our forestation measure is the average annual percentage change in forest cover over the 1990–2000 period, based on FAO measures (World Bank 2002–see Appendix A). Data coverage is more expansive for this period compared to earlier years, and we presume companion improvements in data quality. Percentage change scores in forest cover tend to be less skewed, and therefore offer some methodological advantages relative to the use of raw change measures (Ehrhardt-Martinez 1998), but ultimately our choice of this measure rests on its validity relative to our theorization. For ease in interpretation of our results we emphasize that our variable is annual percentage change in forest cover. Thus, *de*forestation would be a change in a negative direction, while a positive number represents forestation.

Predictor Variables

As control variables, we include forested land as a percentage of total area of a country circa 1990, and a dummy variable for countries with less than 4% of land that is forested (World Bank 2002—see Appendix A). When taken together, these measures adjust for "starting points," including the relatively more unique processes of forestation in largely desert environments.

We also include a modified world-system classification measure, an eleven-category ordinal variable, as a control variable in our regression estimations (Kick 1987). This variable distinguishes the more and less central (i.e., powerful) nations in the world system. In using a generic measure such as this one, we address a range of world-system processes, which are treated individually in other studies (e.g., debt dependency—see Ehrhardt-Martinez 1998).

To test the postulated effects of the processes theorized above, we include three substantive regressors, each measured as an average annual percentage change score. These include average annual change in urban population 1970–90 (P), average annual change in gross domestic product per capita based on purchasing power parity figures for 1975–90 (A) and average annual change in radios per capita, 1970–90 (T). Also, we include another theorized population dynamic, the average annual change in the proportion of the population under age 14 (P) (World Bank 2002).

We calculate descriptive statistics. The means and standard deviations for our variables, along with the zero-order correlations among them, are reported in Appendix B.

Most cross national research endeavors model main effects only, but we proceed to examine the possible lack of homogeneity of slopes among four tiers of the world system (i.e., core, semicore, semiperiphery, periphery; see Appendix A for a listing of countries in each tier) for three of our substantive regressors. In order to test this assumption, we create (k–1=3) slope-dummy variables following Hamilton (1992:88–92). A slope-dummy variable is a form of interaction term created by multiplying a continuous measurement variable (i.e., x_1=Urban Population) by a dichotomous dummy variable (i.e., x_2=Core), which creates a new variable (i.e., Urban Population x Core = x_1x_2). This newly constructed variable x_1x_2 has the values of x_1 for all cases for which the dummy variable was "1" and zeros for all the remaining cases.

The test for homogeneity of slopes consists of entering into a regression model the original main effect (e.g., percent change in urban population), and the k–1 or three slope-dummy variables created from this main effect via the process documented above. A significant coefficient for any of the three slope-dummy variables indicates that the slope for this group/category differs significantly from the excluded group/category.

In order to measure the couplings of national position in the global system to the substantive regressors in a fully specified model that includes important controls, we extend our construction of slope-dummy variables to include all four world-system tiers. We use these four "contextual" or "coupling" variables to demonstrate the different effects of each of the three substantive measures in the context of a fully specified and controlled model. Thus, four independent variables are created, as the original measurement variable is split into four separate regressors.

A finding of "statistical significance" for a specific slope-dummy simply indicates how (un)likely it would be to obtain a coefficient of that magnitude by chance. It does not indicate that the slopes for, say, the semiperiphery and periphery, for the given measurement variable (e.g., urban change) are statistically different as is the case in the technique outlined above (Hamilton 1992). Additionally, the standardized regression coefficients associated with these slope-dummy variables indicate the relative contribution of the independent variable within that tier (e.g., semiperiphery or periphery) to explaining variation in the dependent variable, while simultaneously controlling for the other independent variables included in the model.

We believe this produces a far more appropriate wedding of theory and measurement for world-system theory, since our framework emphasizes the coupling

of analytical domains (rather than merely their generic main effects). We also are interested in the relative effects of the couplings for core, semicore, semiperipheral and peripheral countries compared to one another. Further, we cannot in this case justify theoretically the assumption of "multiplicative effects" associated with traditional, multiplicative interaction terms of two continuous variables.

Model Estimation Procedures

Almost all published quantitative cross-national research such as ours has relied upon ordinary least squares (OLS) regression techniques and we use OLS herein. We verified that the coefficient and standard error estimates from our OLS results were robust by comparing them with findings generated through bootstrap analyses (available from the authors upon request).

We also investigated the potential severity of multicollinearity, following the reasoning of Belsley et al. (1980). An examination of bivariate correlations among all independent variables, and a comparison of standardized regression coefficients (in terms of magnitude and direction) with the bivarite correlation between each regressor and the dependent variable, showed no evidence of estimation difficulties due to multicollinearity. As well, our examination of the matrix of correlations among the regression coefficients themselves reinforced the conclusion that there were no discernable estimation problems caused by multicollinearity. We note, however, that multicollinearity difficulties did surface when we utilized an interaction model technique (Hamilton 1992) to test for homogeneity of the slopes between tiers of the world system, which is typical of many interaction model estimations. We present these findings subsequently.

RESULTS AND DISCUSSION

As noted, we test our hypotheses using a series of multiple regression models. In the first such model, we test only for main effects of the population, affluence and technology variables on deforestation, with controls for forest cover in 1990, world-system position and small forest area. The results are summarized in Table 1.

We find a strong main effect for world-system position—with increasing dependency in the world-system there are significantly higher levels of deforestation. The highest rates of deforestation are in the periphery. This does not imply that evironmental degradation necessarily has alleviated much in the semiperiphery—rather, it is attributable to deforestation in the periphery having gotten more intense in recent years[5].

In addition to the relatively large effect for world-system position, the greater the level of increasing affluence (as reflected in GDP per capita), the less the

Table 1 – Main Effects Model for Average Annual Change in % Forect Cover (1990–2000)

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	0.560	0.577		0.972	0.335	
% Forest cover in 1990	0.003	0.007	0.035	0.348	0.729	–0.161
World-System Position	–0.168	0.061	–0.332	–2.737	0.008	–0.485
Dummy (1 = less than 4% forest cover)	1.698	0.519	0.336	3.272	0.002	0.420
% Urban Population	–0.261	0.106	–0.295	–2.450	0.017	–0.458
Proportion under age 14	0.690	0.332	0.283	2.076	0.042	–0.317
Gross Domestic Product "PPP"	0.090	0.032	0.319	2.825	0.006	0.362
Radios per 1,000	–0.019	0.012	–0.161	–1.557	0.124	–0.387
R–square = .520						

negative environmental outcome in terms of deforestation. In order to control for the relatively low inertia in those countries with small amounts of forest, we added a variable for countries with low levels of initial forest cover, and not surprisingly, this measure turns out to be significantly, positively related to forestation. This simply underscores the fact that all else held equal, countries with small amounts of initial natural forest resources find it relatively easy to obtain high forestation rates with only small absolute changes.

More broadly, the progressively greater deforestation among nations lower in the world-system hierarchy appears in significant part to be attributable to the unequal exchange and consumption patterns that play themselves out in international exchanges. Consider, for example, that the *more* resources per capita a country consumes (as operationalized by its ecological footprint), the *lower* the level of deforestation it tends to have (Jorgenson 2003; Jorgenson and Burns 2003).

With only one exception, each of the regression coefficients has a sign that matches its zero-order correlation with the dependent variable. The one exception is population under age 14, which goes from a significantly ($p<.05$) negative zero-order relationship ($r = -.317$) to a significantly positive standardized regression coefficient (beta weight = .283), when the model has the full complement of control variables. This is an interesting but not totally unexpected finding.

In making sense of this, it bears remembering that while population in general puts a strain on resources, the strain is *not* uniform across age cohorts. Prior research has found working-age population to be highly predictive of deforestation (Burns et al. 1998) and the ecological footprint (York, Rosa and Dietz 2003), and that relationship remains robust even in models controlling for a number of other factors (including other demographic and human ecological variables). These prior findings are consistent with behavioral ecological theory and research, which suggest that adults in a wide array of species tend to put a greater strain on resources than do younger cohorts. In our fully controlled main effects model, the other variables (particularly, and not surprisingly, the urbanization variable) capture much of the negative covariance between a young population structure and forest cover. While fertility rates for women of childbearing age are higher in rural areas, the preponderance of young working-age adults in urban areas leads to the greatest growth there.

It is also worth considering that as this younger cohort ages, it will likely put increasingly greater strain on a number of resources (including, but not limited to, forests and their products) as the next generation competes to find niches for itself. Coupling this with the well-known structure of population pyramids in less-developed countries, we are led to consider the real possibility that in a species with as long a reproductive time lag as humans, the strain on resources, including forests, will very likely increase over the next two decades—and this will be the case even in the highly unlikely scenario of overall population remaining stable over that period.

We next turn attention to the contextual (i.e., zone-specific) effects of our

[5] In comparing our findings with those studies from earlier periods, we are struck by how much of the negative change over the last decade is located in the periphery. For example, Burns et al. (1994) found that for a period beginning in 1965 and ending circa 1990, the average annual percent change in forested land was: core = 0.11, semiperiphery = –0.99, and periphery = –0.18. (We note here that since Burns et al 1994. had a more traditional core/semiperiphery/periphery trichotomy, in contrast to our four-category scheme, their results are not directly comparable. However, even after taking into account the different operationalization schemes, the period differences are remarkable.) In the current study with average annual percent change in forested land as the dependent variable, the mean values from our sample are: core = 0.24, semicore = 1.11, semiperiphery = –0.54, and periphery = –1.55. Thus, while in the previous study, the deforestation rate was about five times greater in the semiperiphery than in the periphery, that ratio has changed dramatically. The data used in this study indicate that in the period 1990–2000, the periphery is deforesting at a rate almost 3 times that of the semiperiphery.

Table 2 – World-System Position by Urban Population Interactions

Table 2a. Test of Different Slopes for Percent Urban Population with Semi-Core the Excluded Category

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	–0.032	0.248		–0.129	0.898	
% Urban Population Main Effect	0.793	0.500	0.900	1.585	0.118	–0.458
% Urban Population Core	–0.004	1.425	0.000	–0.003	0.998	0.143
% Urban Population SemiPeriphery	–1.000	0.480	–0.802	–2.084	0.041	–0.075
% Urban Population Periphery	–1.213	0.485	–1.381	–2.499	0.015	–0.464
R-square = .289						

Table 2b. Contextual 4-Dummy Model for Percent Urban Population

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	0.283	0.705		0.401	0.690	
% Forest cover in 1990	0.000	0.008	–0.004	–0.039	0.969	–0.161
World-System Position	–0.122	0.084	–0.241	–1.453	0.151	–0.485
Dummy (1=less than 4% forest cover)	1.613	0.533	0.319	3.028	0.004	0.420
Proportion under age 14	0.655	0.343	0.268	1.911	0.061	–0.317
Gross Domestic Product "PPP"	0.089	0.032	0.315	2.746	0.008	0.362
Radios per 1,000	–0.017	0.012	–0.145	–1.391	0.169	–0.387
% Urban Population "Core"	–0.078	1.580	–0.006	–0.049	0.961	0.143
% Urban Population "SemiCore"	0.407	0.489	0.088	0.832	0.409	0.268
% Urban Population "SemiPeriphery"	–0.231	0.130	–0.185	–1.771	0.081	–0.075
% Urban Population "Periphery"	–0.310	0.125	–0.353	–2.480	0.016	–0.464
R-square = .538						

regressors. For subsequent regression runs, as described above, we collapse the 11-position world-system variable into the four zones (core, semicore, semiperiphery, and periphery—see Kick 1987). We use slope-dummy variables created for these zones to assess homogeneity of slopes among zones in a restricted interaction model (reported in Tables 2a, 3a, and 4a, respectively), and slope dummy contextual effects in a fully controlled model (reported in Tables 2b, 3b, and 4b, respectively). In this manner, we serially model world-system specific effects, as they vary in context between core, semicore, semiperiphery and periphery nations.

To test for homogeneity of slopes across world-system positions for % urban population, we run a classical main effects model (Hamilton 1992), along with its interaction with three of the world-system zones. The slopes for three zones are tested against the excluded category, in this case the semicore. This model is shown in Table 2a. The significant coefficients for the semiperiphery and periphery demonstrate that the underlying assumption of homogeneity of slopes is violated for this variable—the slopes for the semiperiphery and periphery differ significantly (i.e., are not parallel) from the semicore, although core and semicore slopes run parallel to one another. We remind the reader that interaction models by design tend to exhibit a high degree of multicollinearity. For example, the standardized regression coefficient for the periphery slope dummy has an absolute value of greater than unity—*prima facie* evidence of multicollinearity. So, while we have demonstrated that the slopes for the different zones are not the same through use of this technique, we cannot use it to estimate a more fully controlled and specified model. We offer instead, a more theoretically useful technique that we label a "contextual-dummy" model (reported in Table 2b), in which we report "contextual" effects for the % urban variable for all four world-system positions, while holding constant or controlling for all other variables in the model.

Turning our attention to Table 2b, we find that the coefficients for the "contextual dummy" variables indicate the zone-specific effects of % urban population are negative as we move from the semicore to the periphery. There is a significant negative effect for the periphery ($p < .05$), and semiperiphery (at the $p < .10$), similar to what was demonstrated in the interaction model shown in Table 2a. The results shown in Table 2b support the interpretation that the deleterious effects of urbanization differ across world-system positions, with negative effects occurring in the semiperiphery and periphery zones, even while controlling for all other variables in the model.

In this result, we find little evidence of a "Kuznets" effect; rather, as noted, the effects become increasingly negative moving down the hierarchy of the world-system. It bears noting that while the core and the semicore tend to be more *urbanized*, the semiperiphery and periphery tend to be more rapidly *urbanizing*. In this model, with some qualification, all other variables behave as they did in the main effects model (of Table 1). The main effect for world-system position is non-significant in Table 2b because some of its variance is captured by, or overlaps with, the "contextual dummies."

It is of note that for this model, the contextual effects for the semicore and the core are essentially the same (i.e. null). But as will be seen in subsequent runs, particularly when we test the interaction of GDP/c with world-system position, the coefficient for the semicore appears to more closely resemble that for the semiperiphery. The overall lesson here is that each of the four world-system positions appears in its own way to be uniquely related to forestation. More broadly,

Table 3 – World-System Position by Population Under Age 14 Interactions

Table 3a – Test of Different Slopes for Proportion Under Age 14 with Semi-Core the Excluded Category

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	-0.711	0.269		-2.642	0.010	
Proportion under age 14 Main Effect	-1.313	0.480	-0.538	-2.733	0.008	-0.317
Proportion under age 14 Core	0.568	0.543	0.167	1.046	0.299	-0.173
Proportion under age 14 SemiPeriphery	1.100	0.494	0.375	2.228	0.029	0.032
Proportion under age 14 Periphery	-1.584	1.897	-0.105	-0.835	0.407	-0.261
R-square = .181						

Table 3b – Contextual 4-Dummy Model for Proportion Under Age 14

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	0.068	0.904		0.075	0.940	
% Forest cover in 1990	0.003	0.007	0.047	0.467	0.642	-0.161
World-system position	-0.109	0.099	-0.215	-1.094	0.278	-0.485
Dummy (1 = less than 4% forest cover)	1.795	0.534	0.355	3.362	0.001	0.420
% Urban Population	-0.273	0.106	-0.310	-2.569	0.013	-0.458
Gross Domestic Product "PPP"	0.099	0.033	0.353	2.979	0.004	0.362
Radios per 1,000	-0.015	0.012	-0.130	-1.246	0.217	-0.387
Proportion under age 14 "Core"	0.676	0.586	0.199	1.154	0.253	-0.173
Proportion under age 14 "SemiCore"	0.088	0.548	0.022	0.160	0.873	-0.294
Proportion under age 14 "SemiPeriphery"	0.901	0.367	0.307	2.455	0.017	0.032
Proportion under age 14 "Periphery"	-1.041	1.493	-0.069	-0.698	0.488	-0.261
R-square = .553						

as one might expect for a transitional zone, the semicore appears to resemble the core in some ways, and the semiperiphery in others. It would thus be a mistake, methodologically as well as theoretically, to collapse the semicore into either of these other categories.

In the next two sets of tables (3a & b and 4a & b), we follow this methodology by disaggregating by world-system position the effects of, respectively, population under age 14, and Gross Domestic Product *per capita* (in terms of Purchasing Power Parity).

In Table 3a, we test for interaction of world-system position with changes in proportion of population under 14 with the semicore being the excluded category. Table 3a shows that the slope for the semiperiphery differs significantly from that of the semicore, the excluded category. So, as was discovered above, the assumption of homogeneity of slopes is violated.. As we move from Table 3a to Table 3b we find the same large, significant positive effect for the semiperiphery is replicated in the "contextual dummy" model.

The finding that the age cohort coefficient is significantly positive in the semiperiphery, and is negligible in the other sectors, serves as a complement to previous research (Burns et al. 1998), in which increases in *adult* population in the semiperiphery were found to be associated with deforestation. This result dovetails with earlier findings by indicating a positive effect of proportion of pre-adults on forest levels—but this effect only becomes apparent when controlling for the other variables, suggesting the importance of the interrelations of these social and demographic factors. It does lend qualified support to the environmental Kuznets thesis, in that the strongest effect is somewhere in the middle (in this case, in the semiperiphery), rather than at one of the ends of the world-system hierarchy.

Of course, as students of population "pyramids" (particularly as they apply in the cases of developing countries), will no doubt point out, this large younger cohort will age. As it does so, it is likely to place an increasing strain on resources. Considering this in light of previous findings that serious deforestation practices are occurring in the semiperiphery (Burns et al. 1994), there would appear to be a significant possibility of more serious environmental degradation in the near future in the semiperiphery. It also is worth considering that it is possible for a society to have already taxed the carrying capacity beyond what the overall population figures would tend to show, and even though it still will not experience the full consequences until several decades later when the next generation comes into the age of greatest resource strain. In short, it may get worse before it gets better, particularly in the semiperiphery, but perhaps in the other world-system zones as well.

Turning to our final table, we consider the interaction between world-system position and Gross Domestic Product in terms of Purchasing Power Parity (PPP). The results for the test for homogeneity of slopes are shown in Table 4a.

In Table 4a, we see that the slope for GDP/c in the periphery differs significantly form the core, semicore and semiperiphery, all of which have significantly positive coefficients. Once again the assumption of homogeneity of slopes is violated. In the fully controlled model (Table 4b), we find significant positive effects of the GDP/c variable only in the semicore and the semiperiphery; thus, it is primarily in the mid-range of the world-system that this affluence effect is most robust.

GDP/c, when interacted with zone, gives us insights into how affluence *within* a given world-system position affects forestation. This effect does indeed

Table 4 – World-System Position by Gross Domestic Product "PPP" Interactions

Table 4a – Test of Different Slopes for Gross Domestic Product "PPP" with Periphery the Excluded Category

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	–1.244	0.336		–3.704	0.000	
Gross Domestic Product Main Effect	–0.031	0.055	–0.109	–0.560	0.578	0.362
Gross Domestic Product Core	0.150	0.051	0.427	2.915	0.005	0.171
Gross Domestic Product SemiCore	0.224	0.051	0.664	4.420	0.000	0.438
Gross Domestic Product SemiPeriphery	0.097	0.045	0.455	2.158	0.034	0.067
R-square = .355						

Table 4b. – Contextual 4-Dummy Model for Gross Domestic Product "PPP"

	b	Std. Error	Beta	t	Sig.	Corr.
(Constant)	–0.593	1.218		–0.487	0.628	
% Forest cover in 1990	0.002	0.007	0.031	0.326	0.745	–0.161
World-System Position	–0.041	0.146	–0.080	–0.279	0.781	–0.485
Dummy (1 = less than 4% forest cover)	1.831	0.517	0.362	3.543	0.001	0.420
% Urban Population	–0.237	0.115	–0.269	–2.065	0.043	–0.458
Proportion under age 14	0.560	0.341	0.230	1.642	0.106	–0.317
Radios per 1,000	–0.017	0.012	–0.143	–1.430	0.158	–0.387
GDPC "PPP" "Core"	0.131	0.094	0.374	1.400	0.166	0.171
GDPC "PPP" "SemiCore"	0.196	0.067	0.582	2.915	0.005	0.438
GDPC "PPP" "SemiPeriphery"	0.084	0.032	0.392	2.597	0.012	0.067
GDPC "PPP" "Periphery"	0.075	0.070	0.170	1.069	0.289	–0.357
R-square = .576						

vary by world-system position, and it appears to have the greatest positive effects in the middle zones, with less effect for the core and the periphery. We interpret this as another of a number of manifestations of the complex nature of many of the relationships between key predictor variables and environmental outcomes.

CONCLUSIONS

Overall, our findings support our general theoretical framework, which implies that both world-system dynamics and processes identified in human

ecology are important predictors of environmental outcomes. The contextual effects demonstrated in both our interaction models and our contextual models as specified on the basis of those two sets of theories, give us a number of things to take away from this research.

As human ecology posits, population dynamics have environmental outcomes, including those related to deforestation. But as we have seen, those effects need to be qualified and contextualized, as their effects are shown to differ significantly across zones of the world system.

More generally, we might ask what the analogies of behavioral ecology for the human condition are. Certainly there are numerous lessons for humans here, particularly in terms of population dynamics. Yet one of the worst mistakes we could make would be to apply *any* finding from behavioral ecology without some thought about what is analogous and when. We have seen an example of the cohort effect to which all species are subject; but we also saw how that effect is tempered by world-system position.

The ability to overshoot the earth's carrying capacity needs to be seriously considered. Overshoot can take place in terms of population, affluence or technology, or some combination thereof, yet overshoot in each area is somewhat idiosyncratic. Overshoot in population terms is seen in the relative life chances of generations (e.g. Easterlin 1980). Here, it is possible to overshoot and not see the effects until literally a generation or so later. Some insight into the problem, however, comes from looking closely at cohort effects based on behavioral ecology theory.

As has been noted in a number of studies (e.g. Bergesen 2001; Bergesen and Bartley 2000; Bergesen and Parisi 1997; Burns et al. 1994, 1997, 1998; Ehrhardt-Martinez et al. 2002; Roberts and Grimes 1997, 1999, 2002), the greatest strain on the environment, at least until recently, has been seen in rapidly *developing* countries of the world. While these clearly involve the semicore and semiperiphery, for reasons detailed above, the periphery increasingly is drawn into the (bottom of) the world-system and, in some ways faces some of the same situations as the semiperiphery—except with disadvantages not only relative to the core, but to virtually the rest of the world, including the semiperiphery.

A fruitful strategy for future researchers, along with identifying social processes that lead to environmental impact, is to try to isolate *where* and *when* those processes either are or are not operational, and what the *conditions* are that make them so. A unifying theory may emerge in the future, but before such a theory can meaningfully simplify the field, we need to embrace more complexity in our theorization.

In this paper, we have focused primarily on world-system processes, not only alone but when controlling for, and in some cases interacting with, population variables and a measure of national affluence. Research could just as easily be focused around some other aspect of the overall model. We suggest that, rather than testing one small aspect of a given theory against some aspect of another, and then concluding, based on that particular test, that one theory is supported and the other refuted, we must take seriously the question of theoretical scope conditions. At least for the time being, to be effective, any policy interventions must take scope into account. As a case in point, consider the well-meaning but largely misguided "Green Revolution," which assumed the farming principles developed in temperate regions were universal, and therefore could be applied in a largely unmodified fashion to the Third World, without properly accounting for context. In addition to the obvious differences in social organization, the soils in the largely tropical Third World are quite different from those in the largely temperate developed world. Thus, to embrace the universal principal of being "ecologically sound" in both places, would lead to very different practices in those places, because the same practices would have different outcomes, depending upon where they were implemented (c.f. Colinvaux 1980).

Likewise, in attempting to understand macro-level causes of deforestation, the view that "one model fits all" is inadequate. Rather, as our work demonstrates, it is important to consider contextual effects, particularly in terms of world-system dynamics. Such considerations might include adopting methodological procedures similar to those here, where the homogeneity of world-system slope dummies is empirically ascertained and, as appropriate, models are subsequently estimated based on slope-dummies and other pertinent regressors. If the field is to progress, it is crucial for us to embrace some of these complexities in our theorization and empirical work, including the modeling of non-linearities and interactions of the sort we have examined here.

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Appendix A. Countries in Analyses (N=73)

Core	FRSTP900	FRST_90
United Kingdom	0.76	9.87
Spain	0.58	27.05
Switzerland	0.34	29.23
Italy	0.28	33.01
Netherlands	0.25	10.77
Denmark	0.20	10.49
United States	0.16	24.25
Japan	0.01	65.97
Sweden	0.00	65.91
Belgium	-0.16	22.58
N of cases 10		

Semi-Core	FRSTP900	FRST_90
Israel	5.54	3.98
Ireland	3.16	7.10
Portugal	1.67	33.84
Greece	0.83	25.59
New Zealand	0.47	28.20
Hungary	0.37	19.15
Norway	0.33	27.89
Austria	0.18	46.04
Finland	0.03	71.75
Australia	0.00	20.58
Brazil	-0.36	65.60
N of cases 11		

Periphery	FRSTP900	FRST_90
Bangladesh	1.28	8.98
Congo, Rep.	-0.07	65.11
Central African Republic	-0.12	37.25
Senegal	-0.61	34.57
Mali	-0.64	11.62
Cameroon	-0.77	56.03
Madagascar	-0.83	22.18
Sudan	-1.22	29.97
Benin	-1.90	30.27
Malawi	-1.94	35.16
Zambia	-1.95	53.48
Sierra Leone	-2.32	19.77
Cote d'Ivoire	-2.47	30.71
Togo	-2.64	13.22
Rwanda	-2.98	18.52
Burundi	-5.55	9.38
N of cases 16		

Semi-Periphery	FRSTP900	FRST_90
Egypt, Arab Rep.	3.57	0.05
Algeria	1.29	0.79
Tunisia	0.20	3.21
Turkey	0.20	13.00
India	0.05	21.44
Dominican Republic	0.00	28.44
Saudi Arabia	0.00	0.70
Singapore	0.00	3.28
Syrian Arab Republic	0.00	2.55
Morocco	-0.04	6.80
Korea, Rep.	-0.07	63.84
South Africa	-0.08	7.37
Chile	-0.12	21.02
Guyana	-0.25	88.21
Colombia	-0.34	49.59
Congo, Dem. Rep.	-0.34	61.99
Peru	-0.36	53.05
Venezuela	-0.38	58.59
Paraguay	-0.45	61.92
Kenya	-0.47	31.67
Thailand	-0.64	31.09
Costa Rica	-0.68	41.64
Trinidad and Tobago	-0.71	54.78
Honduras	-0.90	53.37
Mexico	-0.93	32.23
Indonesia	-1.01	65.20
Ecuador	-1.05	43.09
Philippines	-1.21	22.39
Jamaica	-1.30	35.00
Sri Lanka	-1.38	35.39
Panama	-1.39	45.61
Guatemala	-1.44	31.24
Ghana	-1.45	33.12
Nigeria	-2.07	19.22
Nicaragua	-2.39	36.66
El Salvador	-3.39	9.31
N of cases 36		

Appendix B – Descriptive Statistics and Correlations (N=73)

Means and Standard Deviations

	Mean	***Std. Deviation***
Ave. Annual Change in % Forest Cover 1990–2000	–0.41	1.50
% Forest Cover in 1990	31.40	20.76
World-System Position	6.25	2.96
Dummy (1 = less than 4% forest cover)	0.10	0.30
% Urban Population	1.65	1.70
Proportion under age 14	–0.62	0.61
Gross Domestic Product "PPP"	10.17	5.34
Radios per 1,000	11.33	12.90

Correlations

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Change in % Forest Cover 1990–2000	1.000	–.161	–.485	.420	–.458	–.317	.362	–.387
2. % Forest Cover in 1990	–.161	1.000	.047	–.463	–.054	–.072	–.038	.050
3. World-System Position	–.485	.047	1.000	.004	.517	.631	–.382	.374
4. Dummy (1 = less than 4% forest cover)	.420	–.463	.004	1.000	–.123	–.010	.140	–.144
5. % Urban Population	–.458	–.054	.517	–.123	1.000	.505	–.032	.503
6. Proportion under age 14	–.317	–.072	.631	–.010	.505	1.000	–.531	.409
7. Gross Domestic Product "PPP"	.362	–.038	–.382	.140	–.032	–.531	1.000	–.070
8. Radios per 1,000	–.387	.050	.374	–.144	.503	.409	–.070	1.000