13. The environment
The sociology of ecologically unequal exchange in comparative perspective

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The world is “full” and “unequal” (Andersson 2005; see also Babones 2009; Chase-Dunn 1998; Milanovic 2007). This is scarcely a novel assertion and yet the implications remain fundamentally under-appreciated. With 6.8 billion people and counting and the consumption of energy and other natural resources at historically unprecedented levels, human societies are pushing up against the limits of global ecological systems; that the world remains vastly unequal in the wake of such pressures foreshadows the challenges facing the development prospects of the poorer countries—and it is an indication of the links between power, disparate economic development, and patterns of global environmental change.

As environmental changes have become more extensive, intensive, and unequal, world-systems scholars have responded by focusing upon the systemic processes that underlie the widespread disruption of ecological systems (e.g., Burns et al 2006; Frey 1995; Goldfrank et al 1999; Grimes and Kentor 2003; Jorgenson 2003; Lawrence 2009; Rice 2007a; Roberts and Grimes 2002). If capital accumulation is the driving force of world-system dynamics, as Wallerstein (1974) observes, then the energy and other natural resources transformed by labor into a multitude of commodities are deserving of analytical attention, as all economic production is predicated upon ecological additions and withdrawals; moreover, in an increasingly full and unequal world the externalization or imposition of the unpaid, unaccounted reparations of ecological degradation and change, a predictable strategy for enhancing capital accumulation (Wallerstein 1999), only becomes more consequential. The ecological implications of unequal exchange within a stratified world-economy have always been significant but in a full and unequal world, such implications reverberate much more strongly through comparatively disadvantaged societies.

To more fully conceptualize global environmental change it is imperative to recognize the continual appropriation by human societies of energy and other natural resources and the externalization of waste products; the environment, in turn, underpins socio-organizational complexity through available stocks of natural resource endowments and sink capacity services (Dunlap and Rosa 2000). It is also crucial to document variable capital investment tied to the production and extraction of natural resources and systemic patterns of trade—not simply measured in monetary terms but accounting for the biophysical “flows” between countries occupying distinct positions within an international division of labor. Human societies are embedded not only within local, regional, and global ecological systems but interwoven within
systemic patterns of exchange of energy and other natural resources (Podobnik 2002, 2006). To the degree that such exchange is expressed in the overconsumption and under-consumption of natural resources, both affluence and poverty are in part predicated upon the prevailing ecological flows within the modern world-system (Hornborg and Jorgenson 2010; Hornborg et al 2007; Jorgenson et al 2010).

**Ecologically unequal exchange**

Recognition of the substantive, structured ecological relations between countries is increasingly articulated through the theory of “ecologically unequal exchange”; a perspective that describes the unequal material exchange relations and consequent ecological interdependencies within the capitalist world-economy, all of which are fundamentally tied to wide disparities in socio-economic development and power (e.g., Andersson and Lindroth 2001; Hornborg 1998a, 1998b, 2009; Jorgenson 2006, 2009; Jorgenson and Clark 2009, 2011; Rice 2007b, 2009; Roberts and Parks 2007, 2009). Unequal exchange can be broadly defined as the assertion of asymmetrical power relationships between more-developed countries and less-developed countries wherein the former gain disproportionate advantages at the expense of the latter through patterns of trade as well as other structural relationships. The assertion of unequal exchange relations diverges from neoclassical economic thought by inquiring into the historical power relations shaping present comparative advantages, rather than taking present comparative advantage as a given (O’Brien and Williams 2004).

In turn, ecologically unequal exchange refers to the environmentally damaging withdrawal of energy and other natural resource assets from and the externalization of environmentally damaging production and disposal activities within less-developed countries. It constitutes the obtainment of natural capital or stocks of natural resources that yield important goods and services and the usurpation of sink-capacity or waste assimilation properties of ecological systems in a manner enlarging the domestic carrying capacity of more powerful developed countries to the detriment of developing countries. It is therefore focused upon the manner and degree to which less-developed countries tend to fulfill a role in the world-system as a tap for the raw materials and sink for the waste products of industrialized countries, thereby underwriting the disproportionate production-consumption-accumulation processes of the latter.

Ecologically unequal exchange is increasingly recognized as a factor, in addition to labor exploitation, underlying the socioeconomic and environmental disparities between developed countries and less-developed countries. Capital accumulation, in turn, is fundamentally rooted in the alteration of ecological systems and the exploitation of labor (Bunker 1985; Clark and Foster 2009; Foster and Clark 2004; Hornborg 2001). It shapes both the social relations of production and the structure and integrity of ecological systems in an increasingly global manner.

The unequal geographical distribution of energy and other natural resources suggests that trade among nations is a necessity and can contribute to more efficient and productive utilization overall. And yet, in the modern world-economy many export-oriented less-developed countries remain mired in poverty, having failed to exhibit the vertical and horizontal economic diversification and growth that should follow temporally from specialization in their differential comparative advantages (Mahutga 2006). A conundrum, moreover, underlies the juxtaposition between those countries exhibiting the greatest consumption of natural resources relative to those characterized by the greatest degradation or loss of natural resource assets: that is, nations with the highest levels of natural resource consumption, principally the most industrialized countries, are typically characterized by the lowest domestic levels of environmental degradation.
In turn, the most intense natural resource degradation processes frequently beset the poorest countries in the world; those exhibiting minimal natural resource consumption demand. This inconsistency is referred to as the “consumption/environmental degradation paradox” (Jorgenson 2003).

Bunker (1984, 1985) and Bunker and Ciccantell (2005) have crafted a body of comparative-historical work that is particularly responsive to the ecologically unequal connections forged through world-system processes. They illustrate the crucial role reliable access to cheap natural resources has played in fueling the rise of hegemonic powers within a given historical era. They note that orthodox theories of development have insufficiently recognized the fundamental differences between the internal dynamics and logic of accumulation of extractive and productive economies. It is not extraction of natural resources and energy, per se, promoting ecologically unequal exchange but the socio-organizational consequences this tends to produce between and within exporting and importing regions. The historical interactions between modes of extraction and production create path-dependent dynamics shaping the historical development trajectories of differentially situated countries.

Ecological unequal exchange, therefore, is contingent upon differential cross-national social organization and accelerated production-consumption-accumulation linkages in the industrialized countries—facilitating the ability of state and private capital interests to determine global demand for natural resources (Bunker 1985; Hornborg 2001). The capacity to control demand ensures core interests engage in the substantive decisions regarding global export activity and subjects less-developed countries to ever-changing market demands (Bunker 1985; Bunker and Ciccantell 2005). Local populations, social organization, infrastructure, and ecosystems within peripheral extractive regions are often disrupted in the face of malleable core needs. Extractive regions failing to conform to core interests, in turn, are likely to be subject to declining terms of trade or abandoned entirely in lieu of natural resource exports originating elsewhere. Differential cross-national social power, in turn, is based upon historically contingent exchange relationships forged through the ability to control asymmetrical flows of environmental resources and risks (Hornborg 2001).

Quantitative approaches to testing the theory

The use of quantitative comparative methods to assess key assertions of ecologically unequal exchange theory is quite challenging. As implied by the theory, the “vertical flow” of exports from lesser-developed nations to relatively more-developed nations is a structural mechanism through which ecologically unequal consequences are born and maintained. On the flipside, it also matters where human-caused waste is generated, and where it is ultimately sent for disposal.

Over the past few years, a number of macro-sociologists have attempted to create and employ appropriate measures in comparative international studies to test propositions derived from ecologically unequal exchange theory. Early on, Jorgenson (2004) designed a measure—referred to as “weighted export flows”—that quantifies the relative extent to which a nation’s exports are sent to more-developed countries. This weighted index, which involves the use of relational data (export flows between sending and receiving nations) and attributional data (levels of development of receiving nations) in its makeup, includes all primary sector and secondary sector exports. These data were initially used in a study of deforestation from 1990 to 2000, which concluded that the vertical flow of all exports contributes to forest degradation in less-developed countries, net of multiple demographic and political-economic factors, including levels of exports and classic trade dependence measures (Jorgenson 2006). In a related study, Jorgenson and Rice (2005) employ the
same weighted index in a cross-sectional analysis of the per capita ecological footprints of less-developed countries. Results indicate that the vertical flow of exports suppresses the consumption-based environmental demand of less-developed countries, many of which consume natural resources well below globally sustainable thresholds. Shandra et al (2009) use Jorgenson’s (2006) weighted export flows measure as one of multiple predictors in an analysis of industrial organic water pollution in developing nations. Net of other political-economic and human-ecological factors, they find that less-developed countries with relatively greater levels of exports sent to more economically developed nations exhibit higher per capita levels of industrial organic water pollutants emitted per day in the year 2000.

Rice (2007b) conducts a cross-sectional analysis of the per capita ecological footprints of nations for a sample of both developed countries and less-developed countries. To test key tenets of ecologically unequal exchange theory, Rice employs a measure that identifies the percentage of a given country’s exports that are sent to core nations. While such a variable differs from the weighted export flows measures used by others, the general logic of the variable and its suitability for testing hypotheses is quite consistent with the former. Most notably, Rice (2007b) creates interactions between his trade measure and dummy variables for nations in differing income quartiles based on the World Bank’s country income classifications (i.e., low, lower-middle, upper-middle, and high income). Results of cross-sectional models that include the interactions suggest that low- and lower middle-income countries characterized by a greater proportion of exports to the core countries exhibit suppressed per capita footprints relative to nations that are upper middle-income and high income. These results are consistent with propositions of the theory, and highlight non-trivial differences in such structural relationships for nations at varying levels of development.

Combined, the above studies suggest that the resource consumption/environmental degradation paradox is to some extent two sides of the same coin in the context of ecologically unequal relationships between more-developed and less-developed countries. However, they are limited in particular ways. For example, Jorgenson’s (2006) deforestation analysis lacks temporal depth, and the use of a measure for all exports is problematic, since research on forest degradation often emphasizes the relevance of trade in primary sector goods (e.g., Rudel 2005). Jorgenson and Rice (2005) conduct a cross-sectional analysis, which is indeed limited, yet the use of the weighted export flows measure for all commodity types is less problematic in their study, since the dependent variable is the comprehensive per capita ecological footprint. The same cross-sectional limitations apply to Rice (2007b) as well.

Partly in an effort to address some of the weaknesses of prior empirical work, in analyses of deforestation in less-developed countries from 1990–2005, Jorgenson, Dick, and Austin (2010) employ a weighted flows measure for only primary sector goods. Findings reveal a strong association between forest degradation and the vertical flow of primary sector exports (see also Austin 2010; Jorgenson 2010). Likewise, Shandra et al (2009) employ a weighted exports flow measure for primary sector commodities in an analysis of threatened mammals in less-developed countries in 2005. Their export measure is similar to Rice’s (2007) in that it quantifies the percentage of a sending nation’s primary sector exports that go to OECD countries, the latter of which are mostly core nations. Consistent with the theory of ecologically unequal exchange, the results of their negative binomial regression model estimates indicate that levels of threatened mammals in poor nations are associated with flows of primary sector exports to rich nations.

To help resolve the temporal limitations of prior cross-sectional studies, Jorgenson (2009) employs more rigorous methods in random effects panel analyses of the vertical flow of exports and the per capita ecological footprints of less-developed countries from 1975 to 2000. The results indicate a negative association between the overall consumption-based environmental demands
per person and the flow of total exports to relatively more-developed nations, and the association increased in magnitude during the entire 25-year period, suggesting that these relationships have become more ecologically unequal through time. Jorgenson et al (2009) continue in this general tradition, and employ a weighted export flows measure for only primary sector commodities in panel analyses of deforestation and a refined primary sector-oriented ecological footprint—known as the cropland, grazing land, and timber footprint (e.g., “CGT footprint”)—for a sample of less-developed countries from 1970 to 2000. Like the preceding studies, their export flows measure is weighted by the levels of economic development of receiving countries. Jorgenson et al (2009) estimate both fixed and random effects models for both outcomes, which allow for more rigorous hypothesis testing. Consistent with prior research, they find that the vertical flow of primary sector exports contributes to increases in forest degradation and concomitant suppression of the CGT footprint, and the results hold, net of various controls and across both types of panel model estimations.

In perhaps the most thorough cross-national analyses in the ecologically unequal exchange tradition to date, Jorgenson and Clark (2009) integrate the tradition with two contemporary theories in environmental sociology: treadmill of production and treadmill of destruction. Treadmill of production theory focuses on how an economic system driven by endless growth, on an ever larger scale, generates widespread ecological degradation (Gould et al 2008). Treadmill of destruction theory suggests that the military has its own expansionary dynamics, which involve significant environmental and ecological costs (Hooks and Smith 2005). Jorgenson and Clark (2009) argue that the ecologically unequal exchange perspective intersects with both treadmill orientations. The treadmill of production propels the world-economy toward constant expansion, demanding more and more resources to meet its insatiable appetite, especially in the articulated consumer markets of developed countries. Similarly, in the interests of national security, technological innovation, political power, and geopolitical influence, the treadmill of destruction facilitates the increased consumption of resources by the nations’ militaries and their supporting sectors. What is more, increased military strength enhances access to the natural resources and sink capacity of less powerful, underdeveloped nations.

Jorgenson and Clark (2009) argue that the populations of more-developed and militarily powerful countries are positioned advantageously in the contemporary world-economy, and thus more likely to secure and maintain favorable terms of trade allowing for greater access to the natural resources and sink capacity of bioproductive areas within less-developed countries. These advantageous positions facilitate the externalization of environmental costs of resource extraction and consumption to less-developed countries, and help create conditions where more-developed countries and those with more powerful militaries are able to over-utilize global “environmental space.” The misappropriation of environmental space suppresses resource consumption opportunities for many less-developed countries. Given the structure and acceleration of both the treadmill of destruction and treadmill of production, it is quite likely that the consequences of these processes for less-developed countries are more pronounced than for developed countries, and possibly increase through time.

To test their arguments and assess the extent to which these perspectives intersect in meaningful and empirically valid ways, Jorgenson and Clark (2009) create and employ two export flows measures, one of which is weighted by the levels of economic development of receiving countries, while the other is weighted by the military expenditures per soldier of receiving countries. Military expenditures per solider has become a commonly used measure of military power (e.g., Clark et al 2010; Kentor and Kick 2008). The two export flows measures are treated as predictors in panel analyses of the ecological footprints of nations from 1975 to 2000. Most notably, the results of their panel model estimates indicate that countries with relatively higher ecological footprints.
levels of exports sent to economically developed and militarily powerful nations experience suppressed consumption levels, and these effects—that are independent of one another—are especially pronounced and increasingly so for less-developed countries, many of which consume resources well below globally sustainable thresholds. In other words, both forms of structural relationships between nations have become increasingly unequal in ecological contexts.

The entire collection of empirical works discussed thus far focus on how the structure of international trade in ecologically unequal contexts contributes to direct forms of environmental degradation in less-developed countries as well as the suppression of resource consumption for domestic populations, often well below globally sustainable limits. The latter also contributes to the well-being of these populations, which underscores the complexity of resource use and human health associations (e.g., Rice 2008). At the same time, however, it is argued that ecologically unequal exchange relationships are likely to contribute to forms of waste in less-developed countries, and such waste is the result of the off-shoring of environmentally intensive manufacturing or the externalizing of consumption-based environmental costs associated with manufactured goods for the articulated markets in more-developed countries. The focus here is on the treatment of less-developed countries as sinks for waste. While these structural relationships and their potential uneven environmental consequences are also central to the theory of ecologically unequal exchange theory, unlike the approaches discussed earlier, comparative international research on these topics are much more limited. Two notable exceptions in sociology are Roberts and Parks (2007) and Stretesky and Lynch (2009), both of which focus on growth in carbon dioxide emissions in less-developed countries.

Roberts and Parks (2007) estimate cross-sectional models of total emissions, per capita emissions, emissions per unit of production, and cumulative emissions per capita for a large sample of nations. The first three outcomes are measured in 1999, while the fourth measure is a cumulative score for the 1950 to 1999 period. Net of multiple controls, they find that nations with a greater reliance on the export of manufactured goods have higher levels of all four types of emissions. Even though Roberts and Parks (2007) do not include relational measures of trade, their results are consistent with the arguments of ecologically unequal exchange theory.

Stretesky and Lynch (2009) take a moderately different approach that includes relational measures. In their cross-national panel analyses for the 1984 to 2004 period, they assess the extent to which a reliance on exports to the United States relative to other receiving nations contributes to growth in per capita carbon dioxide emissions. Results of fixed effects model estimates indicate that relatively higher levels of reliance on exports to the United States contribute to growth in per capita emissions. While this study highlights the importance in focusing on specific trade relationships and their potential ecologically unequal consequences, the authors do not situate their research in an unequal exchange theoretical framework. Nonetheless, Stretesky and Lynch make notable methodological and substantive contributions to this overall body of literature.

**Conclusion**

The theory of ecologically unequal exchange has become central in academic discourse about society/nature relationships in international contexts. As we highlighted in the first section of this chapter, the perspective has deep analytical roots in world-systems analysis. Comparative-historical work illustrates the long-term systemic processes that create and maintain conditions permitting such exchanges to occur between nations. Thrusts of quantitative research have developed and employed measurements to test certain propositions of the theory, particularly those that concern the environmental consequences of the vertical flow of exports from less-powerful, less-developed nations to the more powerful and developed nations of the Global
North. It seems likely that research will continue to refine such approaches, and apply them to additional questions. There is a particular need for scholars to design measures that allow for testing propositions in comparative international analyses of the other side of the ecologically unequal exchange coin: the extent to which the flow of hazardous materials and other forms of waste from the Global North to the Global South impacts the environment and well-being of human populations in the latter. Further, in line with Jorgenson and Clark (2009), future research on ecologically unequal exchange relationships needs to consider forms of power other than economic, and as Rice (2008) suggests, forthcoming work in this tradition would do well to pay closer attention to the human well-being consequences of such international and global dynamics.

References

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