World Polity, Unequal Ecological Exchange, and Organic Water Pollution: A Cross-National Analysis of Developing Nations

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Abstract

There has been a growth in international organizations concerned with environmental matters. These organizations include international non-governmental organizations (INGOs), inter-governmental organizations (IGOs), and environmental treaties. This article presents cross-national models examining the effects of these organizations on organic water pollution per capita. In doing so, we use lagged dependent variable panel regression models for a sample of 56 developing nations. We find substantial support for world polity hypotheses that these organizations reduce organic water pollution in developing nations. We also find support for unequal ecological exchange theory that exports from poor nations to wealthy nations increase water pollution. We conclude with a brief discussion of the findings and directions for future research.

Keywords: *water pollution, cross-national, world polity, unequal ecological exchange*

Introduction

In recent years, only a few cross-national studies that examine the causes of organic water pollution have been published (e.g., Jorgenson 2006a; Li and Reuveny 2006; Scruggs 1998). The limited treatment of this issue is somewhat surprising given that water pollution is particularly salient to study for a variety of reasons. First, water pollution is largely a result of human activities and, therefore, can be modeled using cross-national data (e.g., Jorgenson 2006a). Second, it is associated with a number of environmental problems such as eutrophication and biodiversity loss in lakes, ponds, rivers, and streams (e.g., Hettige et al. 2000). Third, water pollution adversely affects human health by causing cancer, spontaneous abortions, and birth defects (e.g., Jorgenson and Burns 2004). We elaborate on these points below.

These consequences of water pollution clearly underscore the importance of a better understanding of its causes. In this paper, we articulate cross-national models that build upon recent research on the topic. In doing so, we conduct the first study that considers the impact of three different factors suggested by world polity theory on water pollution among developing nations. These factors are international non-governmental organizations (INGOs), inter-governmental organizations (IGOs), and environmental treaties. We also consider ideas from other relevant perspectives including unequal ecological exchange theory and treadmill of production theory.

Why Study Water Pollution?

There are several important reasons why social scientists should examine the causes of organic water pollution. First, it is largely the result of human activities and, thus, can be modeled.[2] The industrial activities that contribute to organic water pollution include manufacturing of glass, pesticides, medicines, plastics, ceramics, textiles, metals, and paper (Hettige et al. 2000). Some other activities that contribute to water pollution include food processing facilities with inadequate disposal facilities and the dispersing of water used to cool coke during steel production (Miller 2002). The chemi-

cals and byproducts of these manufacturing and industrial processes often end up as waste and are disposed of by being dumped into rivers, lakes, and streams (Clapp 1998).

Second, water pollution has been associated with a number of other environmental problems. For example, many chemicals dumped into waterways are not only highly toxic but also take a long time to decompose (Eckenfelder 2000). Consequently, there is a shift in the pH of water. The pH shift causes certain plants and animals to die off while allowing others to reproduce unchecked, thereby reducing biodiversity (Stanley 1996). Some water pollutants also stimulate oxygen consumption by plants, algae, and bacteria (Hettige et al. 2000). This process reduces levels of dissolved oxygen creating a situation of chronic "stress" that lowers the body weight of aquatic animals and makes them less able to compete for food and habitat (Stanley 1996). It also creates a situation that is toxic to some fish and aquatic invertebrates, which die due to lack of oxygen (World Bank 2003).

Third, water pollution from industrial and manufacturing activity has serious health effects in humans (Jorgenson 2004; Jorgenson and Burns 2004). The toxic chemicals found in water supplies affect people through the process of "bioaccumulation" or the building up of toxins in the fatty tissue of mammals (Czub and McLachan 2004). The long term effects of bioaccumulation in adults include cancer, blood disorders, immunity suppression, and spontaneous abortions (Frey 2003). The buildup of these pollutants has been linked to birth defects (Burns et al. 2003).

Clearly, there are several important reasons why social scientists should be concerned with organic water pollution. Thus, we now turn to a discussion of several theoretical perspectives that make plausible predictions about the determinants of water pollution.

World Polity Theory

World polity theorists hold that INGOs and IGOs play an important role in reinforcing world cultural norms while also constituting world cultural norms (Boli and Thomas 1999). They intervene in global political processes and help shape the language of international treaties dealing with the environment, thereby influencing the normative content of global institutions (Smith 1995; Clapp 1994). Of course, treaties may reduce environmental degradation by limiting or eliminating activities harmful to the environment. However, treaties also provide INGOs and IGOs with an ideal way to highlight if governments do not sign treaties or meet their treaty obligations. In the absence of resources and formal mechanisms of enforcement, INGOs and IGOs monitor adoption and compliance by governments with international environmental agreements. Consequently, INGOs and IGOs point out embarrassing failures and hypocrisies of nations, putting pressure on governments to ratify treaties, adapt their behaviors to international norms, and meet their treaty obligations (Hafner-Burton and Tsutsui 2005; Clark 2003; Finnemore and Sikkink 1998).

It is also important to note that INGOs and IGOs help mobilize support for problem-solving initiatives when national level avenues are either inadequate or blocked (Smith 1999; Keck and Sikkink 1998). It has become increasingly common for INGOs and IGOs to provide support for conservation efforts at local levels (Schofer and Hironaka 2005). In this regard, many environmental INGOs and IGOs fund subnational environmental protection efforts and social movement activity. In fact, Frank et al. (2000) find that nations strongly linked to world society (e.g., those with more INGOs and IGOs) experience a growth in domestic environmental social movements (e.g., domestic NGOs). These ideas can be observed in practice when INGOs (e.g., Greenpeace, Sierra Club, and Conservation International) employ frames and discourses that encourage domestic social movement activity and, in turn, environmentalism within a nation (Frank 1999). In such instances, governments are "squeezed" from above and from below to attend to environmental problems like water pollution (Schofer and Hironaka 2005).

The world polity perspective has been linked to reductions in carbon dioxide emissions as well as deforestation (Shandra 2007; Schofer and Hironaka 2005; Shandra et al. 2004). There has been no research examining the effects of INGOs and IGOs on water pollution. Thus, we seek to apply insights from previous research to an outcome that has not received much attention.

Treadmill of Production Theory

According to Schnaiberg and Gould (1994), the "treadmill of production" is a leading cause of environmental problems. In order to keep profits up, producers must constantly expand production. Seeking to expand production while lowering costs, producers invest in economically efficient technologies that have higher yields per unit of labor. Consequently, there is a displacement of costly workers and an increase in unemployment. The only way to deal with the increased unemployment is to again expand production. Governments also support increased production because it increases tax revenues, thereby providing the means to fund government programs. Through the continual expansion of production, the treadmill increases environmental degradation of various forms by placing more and more demands on resources and by increasing volumes of waste. The most widely used indicator to operationalize treadmill of production theory is GDP per capita (York et al. 2003). Jorgenson

(2006a) found that the treadmill of production increases water pollution.

Unequal Ecological Exchange Theory

The theory of unequal ecological exchange suggests that wealthy nations are advantageously situated within the global economy and are more likely to secure favorable terms of trade (Hornborg 2003; Bunker 1984). This advantage facilitates disproportionate access of wealthy nations to natural resources and ecological sink capacities of poor nations (Rice 2007; Hornborg 2001). Put differently, wealthy nations are able to shift many of the negative environmental externalities associated with their natural resource demands onto poor nations (Jorgenson 2006b; Jorgenson and Rice 2005; Bunker 1984). This "externalization" largely occurs through the "vertical flow" of raw materials and manufactured goods from poor to rich nations. It is organized around multinational corporations or partnerships between indigenous elites and import firms in rich nations (Jorgenson 2006a; Frey 2003; Anderson and Lindroth 2001; Evans 1979).

The logic of unequal exchange can be demonstrated with case study evidence. In 1986, Sandoz, an agribusiness and pharmaceutical corporation, was responsible for the worst river spill in history in which 30 tons of extremely hazardous organophosphates, disulfoton and parathion, spilled into the Rhine in Switzerland (Karliner 1997). The spill killed fish, wildlife, and plants for hundreds of miles along the river. Karliner (1997, 129) writes, "Sandoz responded by cleaning up its operations and moving 60% of its organophosphate production to Brazil. After another ton of disulfoton ended up in the Rhine in 1989, Sandoz moved its remaining pesticide production facilities to India." Today, disulfoton and parathion are exported largely to the United States for use on crops, gardens, and potted plants. Meanwhile, the chemicals have turned up in rivers and streams near the production facilities in India and Brazil (Karliner 1997).

The ideas of unequal ecological exchange have become quite popular with ecological economists, who examine material flows (e.g., Fischer-Kowalski and Amann 2001). These scholars have developed natural capital accounting frameworks for measuring flows of bio-mass and other resources. However, this work is mostly descriptive by design. Thus, Jorgenson (2006b) and Jorgenson and Rice (2005) created a measure of "weighted export flows," which allows researchers to test insights of unequal ecological exchange theory using data for a large sample of nations. The weighted export flow score for a given nation is a function of the proportion of that nation's total exports sent to each receiving country, weighted by GDP per capita of the recipient nation. Jorgenson (2006b) shows that weighted export flows significantly predict deforestation. Jorgenson and Rice (2005) demonstrate the utility of including this measure when studying ecological footprints. Drawing upon the findings of these scholars, we hypothesized that poor nations with high levels of exports sent to wealthy nations should have high levels of water pollution.

Other Theoretically Relevant Factors

Democracy

In a recent study, Li and Reuveny (2006) found that democracy reduces water pollution. They argue that this occurs because of political activism and electoral accountability. Democratic nations generally have higher levels of political activism than repressive nations, because democracies guarantee their citizens certain rights including freedoms of speech, press, and assembly (Ehrhardt-Martinez et al. 2002). Leaders in a democracy must be responsive to such activism because of electoral accountability (Midlarsky 1998). It is also important to note that greater freedom of the press leads to wider diffusion of information, which, in turn, raises public awareness. Therefore, environmental groups are often more successful at informing people and organizing them to act in democratic rather than in repressive nations (Ehrhardt-Martinez et al. 2002).

Structure of Domestic Economy

The neo-classical economic perspective suggests that the overall structure of a domestic economy should help explain patterns of environmental degradation. It is thought that nations with higher levels of manufacturing and industry economic activity tend to consume large amounts of resources and produce higher levels of pollution (Grossman and Krueger 1995). York et al. (2003) find no evidence that non-service based economic activities increase ecological footprints. Likewise, Jorgenson (2006a) finds no evidence that manufacturing economic activity increases organic water pollution.

Nations Included

We include all nations that are not classified as "high income" according to the income quartile scheme of the World Bank (2003). We exclude high income nations because unequal ecological exchange theory is concerned with the structure of exports within poor nations. We also do not include nations formed following the collapse of the Soviet Union because there are no data for these nations in 1990. This yields a sample of 57 nations for which complete data are available on all our variables. We identify and remove two influential cases using Cook's D statistics—see Table 1.

Research Design

We use lagged dependent variable panel regression in our analysis. This approach has been used recently by Jorgenson (2006a), Grimes and Kentor (2003), and Shandra et al. (2003). In this sort of analysis, the dependent variable at one point in time is regressed on itself at an earlier point in time and the other independent variables at that same earlier time point. This method estimates the effects of the independent variables on *change* in the dependent variable between two time points. Our dependent variables are measured in 2000. The lagged dependent variables and independent variables are measured in 1990. This design is also referred to as the "cross-lagged effects" model as shown in the mathematical notation:

$$Y_t = B_0 Y_{t-1} + B_1 + B_2 X_{t-1} + E_t$$

The dependent variable (Y_t) is hypothesized to be determined by the lagged dependent variable ($B_0 Y_{t-1}$), the constant (B_1), the lagged value of the independent variable ($B_2 X_s$), and an error term (E_t).

There are several reasons for using this approach. First, it is regarded as a powerful tool for making causal inferences with non-experimental data over time. This is because the design helps rule out reciprocal effects and reduces the threat of spuriousness due to an apparent effect that can be accounted for by another variable causally prior to both the dependent and independent variables of concern (Finkel 1995). Second, since the correlation between the lagged dependent variable and dependent variable is usually high, panel analysis assigns a maximum explanatory power to the lagged dependent variable. This produces a conservative test of the effect of independent variables on change in the dependent variable (Finkel 1995). Thus, it is appropriate to discuss effects that are significant at the $p < .10$ level as well as the more conventional $p < .05$ and $p < .01$ levels for a two-tailed test (Tabachnick and Fidell 2006). Third, panel regression improves upon unconditional change score models, which assume that the lagged dependent variable has a constant effect on values of the dependent variable (Finkel 1995).

Dependent Variable

Water Pollution

The dependent variable includes total kilograms of organic water pollution released per day from manufacturing and industrial processes per capita in 2000. This measure has been used previously by Jorgenson (2006a). The lagged dependent variable is measured in 1990. The organic water pollution and population data can be obtained from the World Bank (2003). Organic water pollution is measured in terms of biochemical oxygen demand, which refers to the amount of oxygen that bacteria consume in the process of breaking down waste. This is a standard water treatment test for the presence of organic pollutants (World Bank 2003). We log both the dependent variable and lagged dependent variable to reduce problems that may arise with heteroskedasticity (London and Ross 1995).

Independent Variables

Gross Domestic Product

As is standard in such analyses, it is incumbent on us to take into account a nation's level of development in order to make sure that any effects discovered are independent of a nation's level of wealth. In this regard, we employ a measure of gross domestic product per capita at purchasing power parity for 1990. These data may be obtained from the World Bank (2003). We log this data because of their skewed distribution. According to the treadmill of production theory, gross domestic product per capita should increase water pollution in developing nations. It is also important to note that economic development may increase a nation's ability for environmental cleanup (Mol 2000). In this regard, gross domestic product per capita would decrease water pollution.

Urbanization

We also include the percent of a population living in urban areas in the analysis. The data are measured in 1990. They may be obtained from the World Bank (2003). We log this variable to correct for its skewed distribution. It is hypothesized by some that urbanization may increase water pollution because many forms of production that generate water pollution are usually located in urban areas (Smith 1996).

Political Rights

We use Freedom House's (1997) political rights scale as one measure of democracy. Political rights reflect the degree to which a nation is governed by democratically elected representatives and has fair, open, and inclusive elections. The variable is a seven-point scale with the following codes: free (1-2), partially free (3-5), and not free (6-7). We multiply this variable by negative one so that high scores are indicative of high democracy. We anticipate that political rights should reduce water pollution.

Civil Liberties

We also include Freedom House's (1997) civil liberties scale as an alternative indicator of democracy. Civil liberties reflect whether within a nation there is freedom of press, freedom of assembly, general personal freedom, freedom of private organizations, and freedom of private property. The variable has the same seven-point coding scheme as political rights. We also multiply this variable by negative one so that high scores

represent high democracy. Like political rights, civil liberties should reduce water pollution in the developing world.

Government Expenditures

We also include total government expenditures as a percentage of GDP in 1990. These data are available from the World Bank (2003). In a recent study, Shandra (2007) finds that government spending contributes to deforestation because governments tend to invest in activities that degrade the environment to maximize economic growth. Thus, we hypothesize that government spending should increase water pollution.

Industrial Economic Activity

We also include the industrial activity as a percentage of GDP in 1990. These data may be obtained from the World Bank (2003). As noted above, it may well be that higher levels of economic activity in industry increase water pollution.

Manufacturing Economic Activity

We also include manufacturing activity as a percentage of GDP in 1990. These data may be obtained from the World Bank (2003). We include this variable to control for the structure of the domestic economy. We hypothesize that nations with a larger amount of economic activity in manufacturing should have more water pollution.

International Non-Governmental Organizations

We include the total number of INGOs in a nation for 1990. Smith (2004) collected information from *The Yearbook of International Associations* and coded those INGOs explicitly focusing on the environment. This variable has recently been used by Shandra (2007) and Smith and Wiest (2005). We divide the total number of INGOs in a nation by its population in millions for 1990. The population data may be obtained from the World Bank (2003). We log this variable to correct for its skewed distribution. World polity theory suggests that more INGOs per capita should reduce water pollution.

Inter-Governmental Organizations

We also include the total number of memberships in environmental IGOs for a nation in 1997. One hundred IGOs were coded as "environmental" by the Center for International Earth Science Information Network. The list is available from them upon request. We divided the total number of memberships in IGOs for a nation by its total population size in millions for 1990. The population data may be obtained from the World Bank (2003). We log this variable to correct for its skewed distribution. World polity theory argues that more IGOs per capita should reduce water pollution. We use different measures of world polity theory because multiple indicators of a similar concept also allows us to sample from a larger "conceptual domain," thereby measuring different aspects of a theoretical construct with separate variables (London and Ross 1995).

Environmental Treaty Ratification

We also include Dietz and Kalof's (1992) state environmentalism index A per capita. This index is a cumulative measure of ratification of international environmental treaties from 1963 to 1987. The data may be obtained from Dietz and Kalof (1992). World polity theory argues that environmental treaty ratification should reduce organic water pollution.

Jorgenson and Rice Export Flows

We use Jorgenson and Rice's (2005) novel measure of weighted export flows to test the theory of unequal ecological exchange—see also Jorgenson (2006b). This is a comprehensive index that weights export flows of a nation by the GDP per capita of the receiving nation. The data are measured in 1990 and may be obtained from Jorgenson (2006b). The weighted export flows measure the relative extent to which exports are sent to wealthier nations. See Jorgenson (2006b) or Jorgenson and Rice (2005) for a detailed discussion involving the construction of this measure.[3] We log this variable to control for its skewed distribution. Unequal ecological exchange theory suggests that weighted export flows should increase organic water pollution.[4]

United Nations Export Flows

We also include the percentage of total exports sent from a nation to high income nations. These data may be obtained from the United Nations (2006). This variable is logged to control for its skewed distribution. We use these data to test the unequal ecological exchange hypothesis that higher levels of exports sent to rich nations increase water pollution.

Total Exports

We also include total exports as a percentage of GDP for 1990. These data may be obtained from the World Bank (2003). We log this variable to control for its skewed distribution. Jorgenson and Rice (2005) use this variable to measure "export intensity" and hypothesize that it should increase organic water pollution because poor nations often produce exports in environmentally inefficient facilities (Grimes and Kentor 2003; Smith 1996).

Findings

In Table 1, we present the ordinary least squares estimates of organic water pollution. In every equation, we include the lagged dependent variable, gross domestic product

per capita, urbanization, government expenditures, industrial economic activity, manufacturing economic activity, total exports, and an indicator of export flows. We include Jorgenson and Rice's (2005) index of export flows in odd numbered equations and the United Nations (2006) index of export flows in even numbered equations. We also include a measure of democracy. We examine the effect of political rights in equations (1.1), (1.2), (1.5), and (1.6) and civil liberties in equations (1.3), (1.4), (1.7), and (1.8). We include INGOs in equations (1.1) through (1.4), IGOs in equations (1.5) through (1.8), and environmental treaty ratification in equations (1.9) through (1.12).

Table 1. Ordinary Least Squares Estimates of Water Pollution per Capita Including INGOs, IGOs, and Treaty Ratification

Independent Variables	Equation 1.1a	Equation 1.2b	Equation 1.3a	Equation 1.4b	Equation 1.5a	Equation 1.6b
Intranational Variables						
Water Pollution Per	.976***	.983***	.982***	.988***	.978***	.982***
Capita, 1990	.922	.931	.928	.935	.924	.930
	(16.290)	(16.795)	(16.509)	(17.153)	(16.468)	(17.034)
Gross Domestic Product	.095	.095	.083	.105	.074	.093
Per Capita, 1990	.076	.076	.066	.084	.060	.074
	(1.173)	(1.173)	(1.004)	(1.322)	(.920)	(1.178)
Industrial Economic	-.006	-.002	-.006	-.002	-.002	.001
Activity, 1990	-.064	-.025	-.063	-.019	-.023	.003
	(-1.061)	(-.441)	(-1.046)	(-.336)	(-.436)	(.055)
Manufacturing Economic	-.001	.001	-.001	-.001	-.005	-.003
Activity, 1990	-.001	.004	-.003	-.001	-.031	-.022
	(-.019)	(.089)	(-.061)	(-.023)	(-.693)	(-.490)
Urbanization, 1990	-.243**	-.250***	-.224*	-.249**	-.161	-.185*
	-.136	-.139	-.125	-.132	-.090	-.102
	(-2.280)	(-2.420)	(-2.136)	(-2.343)	(-1.537)	(-1.813)
Political Rights, 1990	.056**	.040			.043*	.031
	.109	.077			.083	.061
	(2.080)	(1.512)			(1.730)	(1.262)
Civil Liberties, 1990			.079*	.055		
			.113	.079		
			(2.054)	(1.459)		
Government Expenditures,	-.001	-.006	-.002	-.008	-.003	-.007
1990	-.002	-.031	-.011	-.041	-.017	-.035
	(-.041)	(-.763)	(-.243)	(-1.067)	(-.381)	(-.882)
International Variables						
International NGOs, 1990	-.348***	-.270	-.392***	-.292**		
	-.140	-.109	-.158	-.118		
	(-2.558)	(-2.124)	(-2.667)	(-2.163)		
Inter-Governmental					-.245***	-.191**
Organizations, 1997					-.133	-.104
					(-2.743)	(-2.186)
Jorgenson and Rice	.420*		.284***		.243	
Export Flows, 1990	.072		.158		.042	
	(1.675)		(3.044)		(.985)	
United Nations Export		.374***		.368**		.295*
Flows, 1990		.095		.093		.075
		(2.424)		(2.366)		(1.894)
Total Exports, 1990	.307***	.224**	.457*	.204**	.293***	.215**
	.171	.122	.079	.110	.163	.117
	(3.220)	(2.382)	(1.769)	(2.219)	(3.272)	(2.374)
Adjusted R-Square	.929	.934	.929	.934	.931	.934
Number of Cases	56	56	56	56	56	56
Mean VIF	2.188	2.095	2.101	2.190	2.177	2.113
Highest VIF	3.308	3.299	3.404	3.389	3.349	3.348

Table 1. Ordinary Least Squares Estimates of Water Pollution per Capita Including INGOs, IGOs, and Treaty Ratification *(continued)*

Independent Variables	Equation 1.7a	Equation 1.8b	Equation 1.9a	Equation 1.10b	Equation 1.11a	Equation 1.12b
Intranational Variables						
Water Pollution Per	.983***	.985***	.976**	.984**	.982***	.987***
Capita, 1990	.928	.933	.922	.931	.927	.934
	(16.669)	(17.251)	(15.762)	(16.782)	(15.949)	(16.974)
Gross Domestic Product	.063	.084	.094	.108	.090	.103
Per Capita, 1990	.051	.067	.075	.087	.072	.082
	(.767)	(1.045)	(1.116)	(1.355)	(1.053)	(1.285)
Industrial Economic	-.002	.001	-.001	.002	-.001	.002
Activity, 1990	-.019	.009	-.004	.017	-.001	.022
	(-.346)	(.179)	(-.064)	(.336)	(-.016)	(.414)
Manufacturing Economic	-.006	-.004	-.005	-.002	-.005	-.004
Activity, 1990	-.037	-.029	-.031	-.023	-.024	-.027
	(-.814)	(-.623)	(-.648)	(-.495)	(-.707)	(-.567)
Urbanization, 1990	-.139	-.172*	-.172	-.199*	-.158	-.191*
	-.077	-.095	-.096	-.110	-.088	-.106
	(-1.345)	(-1.707)	(-1.596)	(-1.943)	(-1.480)	(-1.881)
Political Rights, 1990			-.029	-.022		
			-.056	-.043		
			(-1.139)	(-.911)		
Civil Liberties, 1990	.059*	.045			-.033	-.028
	085	.043			-.047	-.059
	(1.725)	(1.282)			(-.970)	(-.854)
Government Expenditures,	-.005	-.008	-.108	-.140	-.120	-.158
1990	-.026	-.043	-.041	-.052	-.049	-.059
	(-.574)	(-1.127)	(-.892)	(-1.264)	(-1.088)	(-1.480)
International Variables						
Inter-Governmental	-.267***	-.208**				
Organizations, 1997	-.145	-.113				
	(-2.865)	(-2.273)				
Environmental Treaty			-.085*	-.080*	-.087*	-.083*
Ratification, 1990			-.082	-.076	-.084	-.079
			(-1.730)	(-1.711)	(-1.748)	(-1.743)
Jorgenson and Rice	.254		.265		.278	
Export Flows, 1990	.044		.046		.048	
	(1.033)		(1.082)		(1.135)	
United Nations Export		.282*		.324**		.320**
Flows, 1990		.072		.082		.081
		(1.777)		(2.076)		(2.027)
Total Exports, 1990	.274***	.201***	.235***	.176**	.221***	.164*
	.152	.109	.130	.095	.123	.088
	(3.082)	(2.240)	(2.718)	(2.073)	(2.523)	(1.919)
Adjusted R-Square	.931	.935	.923	.933	.925	.933
Number of Cases	56	56	56	56	56	56
Mean VIF	2.030	2.125	2.097	2.108	2.109	2.125
Highest VIF	3.470	3.481	3.358	3.357	3.428	3.445

a) The Philippines is removed from the analysis because it is an influential case.

b) Jordan is removed from the analysis because it is an influential case.

c) * indicates $p < .10$ ** indicates $p < .05$ *** indicates $p < .01$ for a two-tailed test.

d) The first number reported is the unstandardized regression coefficient, the second number is the standardized regression coefficient, and the third number in parentheses is the t-statistic.

We organize our analysis in this way for three important reasons. First, we want to avoid potential problems with multicollinearity. When we include INGOs and IGOs in the same equation, variance inflation factor scores are well above a value of ten. This is likely the result of the high bivariate correlation between these variables (e.g., r = .755 for INGOs and IGOs). A similar situation occurs when we include both political rights and civil liberties in the same model (e.g., r = .701 for political rights and civil liberties). However, the highest variance inflation factor score is only slightly above a value of three for every model when we examine the effects of these variables in separate models. At the same time, mean variance inflation factor scores for these models are all around a value of two. These values are well within acceptable limits, indicating that multicollinearity should not be a problem (Tabachnick and Fidell 2006). Second, multiple indicators help guard against potential problems associated with measurement error because one indicator may be imperfect but several measures are less likely to have the same error (Paxton 2002). This is why we use two different export flow indicators and three measures of world polity theory. Third, the sequential use of "cognate" but "distinct" indicators of more than one independent variable should shed considerable light on the complexity of dynamics involving the issue under investigation (London and Ross 1995).

Let us begin by focusing on our significant findings. First, we find substantial support for ideas of unequal ecological exchange theory. The Jorgenson and Rice (2005) export flow coefficients are positive and significant in equations (1.1) and (1.3). The United Nations export flow coefficients are positive and significant in every equation in which the variable is included. Second, we also find that total exports tend to increase organic water pollution. The coefficients for this variable are positive and significant in every equation of Table 1. Third, we find support for world polity theory. The coefficients for INGOs are negative and significant in equations (1.1) through (1.4). The coefficients for IGOs are negative and significant in equations (1.5) through (1.8). The coefficients for treaty ratification are negative and significant in equations (1.9) through (1.12).

There are also some unexpected findings. First, the coefficients for urbanization are negative and significant in eight of 12 equations. From above, we hypothesized urbanization would increase organic water pollution. This finding is surprising. It may well be the case because urbanization is often accompanied by a shift from manufacturing and industry to a more service-oriented economy, which leads to less organic water pollution.

There are some other non-significant and inconsistent findings that also deserve to be mentioned. First, we find limited support that democracy affects organic water pollution. The political rights and civil liberties variables are only significant in four of 12 equations. Second, we also find no support for hypotheses concerning government spending. The coefficients for this variable fail to reach statistical significance.[5] Third, we do not find support that the structure of the domestic economy affects organic water pollution. The coefficients for economic activity from manufacturing and industry are not significant in any equations.

A problem that commonly arises in cross-national research is that of missing data. Statistical procedures such as multivariate regression analysis generally assume that each country has complete data. However, for numerous reasons, countries may be missing values on one or more of the variables under investigation. When this is the case, questions emerge about the extent to which inferences about the parameters and tests of statistics are influenced by the presence of incomplete data. The most common method of dealing with missing data in cross-national research is listwise deletion. However, serious problems may arise when using it for handling missing data.

When using listwise deletion, nations with any missing information are excluded from the analysis. An obvious advantage of this approach to missing data is its simplicity. However, Allison (1999) discusses three potential drawbacks. First, the effective sample size with listwise deletion only includes those nations with complete records, and, consequently, this number can be substantially smaller than the original sample size if missing observations are scattered across many nations. Second, nations that are excluded will often be the poorer countries that have fewer resources to allocate toward record keeping. Thus, the final sample may not be representative of the poorest nations. Third, different models may be estimated with a different sample of nations in an attempt to maximize the use of data availability. In these instances, Allison (1999) concludes listwise deletion may result in biased estimates.

Therefore, we attempt to determine if our estimates are biased by listwise deletion by using Arbuckle's (1996) full information maximum likelihood estimation routine to handle incomplete data. This approach has been used by Shandra (2007) and Paxton (2002). It works by creating a likelihood for the entire sample by summing the likelihoods of each case using whatever information is available for each case. It yields more consistent and efficient estimates than listwise deletion of missing data (Arbuckle 1996).

The size and significance of the full information maximum likelihood estimates are remarkably similar to the listwise deletion estimates. For instance, the coefficients for both weighted export flow measures remain positive and significant in respective equations. Likewise, the coefficients for INGOs, IGOs, and environmental treaties remain negative

and significant in every equation. Thus, there appears to be little evidence indicating that the listwise deletion results are biased. We do not present these results for sake of space.

Discussion and Conclusion

We began this study with the goal of considering some insights that have not yet been incorporated into research of water pollution among poor nations. In this regard, we test and find support for world polity theory. In particular, we find that INGOs, IGOs, and environmental treaties reduce water pollution among a sample of developing nations. At the same time, we also find that export flows from poor nations to rich nations increase water pollution. This finding supports insights from unequal ecological exchange theory. We attempt to increase the reliability of these findings in a few ways. First, we demonstrate that "cognate" but "distinct" indicators of a concept exert similar effects on water pollution. Second, the effects of our multiple indicators are consistent across different model specifications and techniques for handling missing data. Taken together, we are confident in the reliability of our results.

We conclude with some possible directions for future research. Payne (1995) argues that the ability of INGOs, IGOs, and treaties to enact change may be affected by the degree of democracy within a nation. This may be the case because democratic nations provide the context for INGOs and IGOs to change policy (Lewis 2000). For example, democratic nations guarantee freedoms of speech, press, and assembly. However, repressive nations may pass laws that "dull the sharp edge of non-governmental organization criticism" (Clark 1991, 79). These policies include government approval of project funding and registration of members. A repressive nation may also outlaw strikes, protests, and unions (London and Ross 1995). This insight could be applied to water pollution and further our understanding of the factors shaping this phenomenon.

Endnotes

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2. This analysis focuses *only* on organic water pollution resulting from industrial activities. It is important to note that organic water pollution can also result from other sources, especially agricultural runoff and livestock operations (Hettige et al. 2000). Nevertheless, data are not available on organic pollution from such sources (World Bank 2003).
3. Jorgenson (2006b) and Jorgenson and Rice (2005) construct the weighted index in three steps. First, they convert exports to each receiving nation into the proportion of the sending nation's total exports. Second, they multiply each proportion by the corresponding receiving country's GDP per capita. Third, they sum the products of the calculations in step two. The sum quantifies the relative level of exports sent to more developed nations.
4. The weighted export flows data from Jorgenson (2006b) are only available for a limited number of nations. After listwise deletion of missing data, the sample size for our models including this measure was equal to 40 nations. As a result of the reduced sample, we impute missing data for this variable using mean substitution by income quartile for 17 nations and present these results. However, we repeat the analysis using information on only the 40 nations for which data are available. The results were similar to the findings presented. We also estimated all our models using a full information maximum likelihood procedure for missing data to guard against potential problems with both listwise deletion and mean substitution.
5. An astute reviewer pointed out that it may be important to examine not only total government spending per se but also how governments allocate their resources (Bradshaw and Schafer 2000). Ideally, we would like data for government spending on the environment. However, such data are not available. Nevertheless, we did examine separately the effects of public expenditures on health as a percentage of GDP in 1990 and public expenditures on education as a percentage of GDP in 1990. The data may be obtained from the World Bank (2003). The coefficients for both variables were negative but failed to explain any significant variation in organic water pollution. We do not present these results for sake of space, but they are available from the authors upon request.

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