PREDICTIVE FACTORS TO EXPLAIN THE EXPORT OF HAZARDOUS WASTE BY PARTIES TO THE BASEL CONVENTION

by

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DEDICATION

My dissertation is dedicated, first and foremost, to my husband, Paul, who has been so supportive of me, in so many ways, throughout this journey. His unwavering belief in me and my ability to complete this PhD program kept me always moving forward. I would also like to thank my children, Katie and Chris, for their constant support and encouragement and for keeping it fun.

My dissertation is also dedicated to the memory of my parents, who instilled a life-long love of learning in me, and my late brother, Richard, who as a high school English teacher inspired his students to reach further than they thought possible. Thank you all.

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Abstract

PREDICTIVE FACTORS TO EXPLAIN THE EXPORT OF HAZARDOUS WASTE BY PARTIES TO THE BASEL CONVENTION

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The number of legal and illegal transboundary shipments of hazardous waste has been increasing in the past decade. The mismanagement of some of these shipments has resulted in illness and death, along with widespread environmental contamination. Despite efforts of the Basel Convention, a treaty that limits the transboundary shipment of waste, to reduce these shipments through mandating the treatment and disposal of any wastes as close as possible to the point of generation, recent national export data indicates that over 80% of all reporting parties to the Basel Convention export part or all of their hazardous waste. The amount of hazardous waste involved in a transboundary movement increased 22% between 2004 and 2006. This study examines select social (level of human development), economic (trade extent, structure, and openness), political (level of democracy and tolerance to civil society), and technological (technology development support) factors that may drive a country to export its waste rather than manage it within

its national borders. This issue is examined at the national level because it is the responsibility of the national government to grant permission for these shipments to proceed. Self-reported national data is often incomplete, so missing values analysis was conducted and multiple imputation was performed on the research dataset. Multivariate linear regression was then conducted on each of the five imputed datasets, and the results were pooled. The results of this analysis indicate that technology development support, as determined by a proxy variable consisting of a country's gross expenditure on research and development in relation to its gross domestic product is a significant predictor of hazardous waste export and that, as technology development increases, hazardous waste exports decrease. The development of in-country waste minimization and waste treatment/disposal technologies may be one explanation for this result. Additional exploratory analyses indicate that the broadness of the trade structure, related to trade diversity, and the level of democracy are predictors of a country's propensity to export waste, when the technology development support variable is removed from the regression analysis. National-level policy options to address these results may include the encouragement of increased support of research and development, especially in the area of environmentally sound waste management technologies. Also examined are the more immediate needs of the government officials who are responsible for these transboundary shipments. Collective action theory provides the framework through which interactions relating to these shipments will be examined at the national, regional, and international levels.

Chapter 1: Introduction

1.1 Research Topic

Over the past three decades, repeated incidents of illegal and unsafe handling of transboundary shipments of hazardous waste have resulted in injury and death, as well as severe environmental contamination (Clapp, 2001; Kamuk & Hansen, 2007; Kitt, 1995; Krueger, 1998; Singh & Lakhan, 1989). For example, in 1998, six people were killed and hundreds injured in Cambodia when they were exposed to illegally imported mercury-containing waste (Hess & Frumkin, 2000). In 2006, 10 people were killed, 30,000 injured, and 100,000 sought medical attention in Cote d'Ivoire when an illegal shipment of hydrogen sulfide-containing waste was deposited in several areas throughout Abidjan (Voice of America, 2006). In 2007, researchers determined that the children of Guiyu, China had elevated blood lead levels attributable to primitive recycling of illegally imported e-waste (Huo et al., 2007).

In response to inadequate management of hazardous waste in the 1970s and 1980s, a multilateral environmental agreement (MEA), known as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, hereafter referred to as the Basel Convention, was developed (Kummer, 1992; Krueger, 2002;

UNEP, 2009a). Shipments of illegal hazardous waste continue to be detected, especially in developing countries that do not have strong environmental regulatory programs to ensure compliance with international waste conventions (IMPEL, 2006; WCO, 2009; Yuen, 2009).

The amount of illegal hazardous waste shipments is harder to quantify, as only those shipments that are intercepted are reported. Numerous sources have reported that much of the illegal waste movement is controlled by organized crime (Interpol, 2006, 2009; Massari & Monzini, 2004). It is estimated that these criminal groups generate revenues of $1-2 billion (U.S. dollars)/year from the dumping of trash and hazardous waste (International Crime Threat Assessment, 2000).

Since its inception in 1989, the Basel Convention's main goals have been to minimize hazardous waste generation at its source, reduce transboundary shipments of these materials, and manage all wastes in an environmentally sound manner (UNEP, 2009a). Dr. Mostafa Tolba (UNEP, 1992), then Executive Director of the United Nations Environment Program (UNEP), reminded participants at the First Meeting of the Conference to the Parties to the Basel Convention in 1992 that "the central objective of the Convention was to reduce to a minimum the generation of hazardous waste and ensure that whatever was produced was disposed of in an environmentally sound manner as close to the point of generation as possible" (p. 2).

Agenda 21, which was adopted by more than 178 nations at the UN Conference on Environment and Development (UNCED) held in Rio de Janerio, Brazil in 1992, specifically addressed the environmentally sound management of hazardous waste, including the prevention of illegal international traffic in these wastes. One of the overall goals of this comprehensive plan is the "eliminating or reducing to a minimum transboundary movements of hazardous wastes, consistent with the environmentally sound and efficient management of these wastes" (United Nations, 2009, Section 20.7).

The report on the implementation of the Basel Convention Strategic Plan to 2010 reiterates this goal as one of its primary activities (UNEP, 2008a). However, little has actually been accomplished that will facilitate the reduction of transboundary movements (UNEP, 2008b); in fact the number of these waste movements has increased (European Environment Agency, 2009). A review of the data posted by the Basel Secretariat for 2006 shows that over 80% of the reporting countries are exporters of hazardous waste, with ten countries being responsible for 68% of the total exports of hazardous waste (Basel Convention, 2010). Why do countries export their hazardous waste rather than manage it within their own national borders? This research quantitatively examines what factors can predict whether a country will comply with the provision of the Basel Convention to reduce transboundary movements of hazardous waste and what might be some actions that could foster increased compliance, thereby reducing the amount of legal waste entering international trade. This cross-national research first seeks to understand the factors that drive the legal hazardous waste trade and then to identify

potential policy options through a quantitative analysis of social, economic, political, and technological factors. The research also takes a qualitative look at what government officials responsible for transboundary hazardous waste shipments indicate as necessary to effectively implement the Basel Convention. This research identifies and examines actions that have the potential for making the greatest impact in reducing transboundary shipments of hazardous waste, thereby maximizing the use of available national and international funding allocated to this issue. Fifty-five countries that have ratified the Basel Convention and submitted useable data on hazardous waste exports to the Basel Convention for the 2005-2006 time frame are included in the research dataset.

1.2 Importance of the Research

The Organization for Economic Cooperation and Development (OECD) acknowledges that addressing transboundary and global environmental challenges through international governance is a key policy opportunity for the next twenty years (OECD, 2008). The mishandling of illegal shipments of hazardous waste by importing countries, which historically have been developing countries, has received much of the attention in the literature and the media. Continuing efforts to improve enforcement and waste management capabilities in these importing countries are being conducted by various international organizations such as the Secretariat of the Basel Convention, the World Customs Organization (WCO), the United Nations Office for Drugs and Crime (UNODC), and various regional networks and national entities. These efforts are

targeted at specific vulnerable areas, for example, West African ports that have historically received dangerous illegal hazardous waste shipments, and strive to create effective environmental enforcement on a regional scale. Although this end-of-the-pipe approach makes an immediate impact, the effect is geographically limited and does not address the core problem, which is the continued export of hazardous waste by developed countries.

There has been geographically limited research conducted to understand what drives the importation of hazardous waste by selected countries (O'Neill, 2000). Much of the literature has focused on the importing countries, which are the recipients of the waste, rather than addressing the exporting countries, which are the sources of the waste (Clapp 1994, 2001; Singh & Lakhan, 1989). This research examines this issue from the perspective of the exporting country. An alternative front-end policy approach can be effective if it is aimed at addressing the management of hazardous waste at its source, rather than on the repeated cleanup of contamination at the receiving end.

1.3 Relationship to Collective Action Theoretical Framework

Currently there is no single global environmental regulatory body with enforcement capability. The Secretariat of the Basel Convention has no supranational regulatory or enforcement authority, relying on individual nations to promulgate and enforce implementing legislation. Decisions, as well as any related legislative and enforcement

actions, are made at the national level with input from a wide variety of entities, including various levels of governmental agencies, non-governmental organizations, and industrial interests. "Collective action occurs when more than one individual is required to contribute to an effort in order to achieve an outcome" and can apply to many levels of governance (Ostrom, 2004, p. 1). It is the strategic activities conducted through this collective action of these entities that attempt to address the environmental challenges. Environmental treaties provide a mechanism for coordination of national efforts and a way to achieve specific goals in what amounts to a global anarchy. Some treaties have been successful in accomplishing stated goals, such as the Montreal Protocol to reduce stratospheric ozone depletion. Others have not been as successful, such as the Kyoto Protocol efforts to reduce greenhouse gases. This research examines what factors lead to successful collective action at the national level, as exhibited through compliance with one of these environmental treaties, the Basel Convention. The research also qualitatively examines the needs of practitioners who are responsible for transboundary waste movements.

There are numerous studies that look at why countries participate in global treaties (Congleton, 1992; Earnhart, 1997; Fredriksson & Gaston, 1999; Levy, 1995; Murdoch, Sandler, & Vijverberg, 2003; Olson, 1993; Roberts, Parks, & Vasquez, 2004). However, compliance with the treaty provisions after ratification is not the focus of these studies. The research by Barrett and Graddy (2000) is one of the few studies to consider the level of compliance that a country demonstrates after signing an agreement. The authors

determine quantitatively that lower concentrations of selected environmental pollutants (SO_2, smoke, and heavy particulates) are correlated with increased democracy. Whether these concentrations actually met a country's commitment is not addressed in their study. Neumayer (2002b) takes this concept a step further and concludes that, as the prevalence of democracy increases worldwide, so will commitments to the environment. However, only one of his six indicators of commitment, namely percentage of a country's land area under environmental protection, actually involves an action on the part of the country to implement a specific provision of an agreement. None of the studies in the literature reviewed specifically address the issue of compliance with the Basel Convention or the issue of transboundary movement of hazardous waste.

1.4 Renewed Interest in Transboundary Shipments of Hazardous Waste

There is currently a renewed interest in developing a better understanding of the legal and illegal international waste trade, which makes this research timely.

- The Basel Convention's Action Plan for 2009-2010 calls for an assessment of compliance with the implementation of the obligation to reduce transboundary hazardous waste shipments, in order for the Basel Secretariat to better understand the waste trade and to reinitiate its efforts to reduce the international movement of waste. When analyzing the global trends in transboundary movements of waste, the Basel Convention notes that there is no evidence that hazardous wastes are being transferred from the wealthier countries to the poorer countries, as was the

case prior to the implementation of the Basel Convention, and the number of transboundary movements is increasing (Basel Convention, 2010). The data from the Basel Convention only account for the hazardous waste that is legally shipped. Developing countries continue to intercept illegal shipments of hazardous waste originating from developed countries (INECE, 2010a; WCO, 2009).

- In March 2009, the European Environment Agency released a report that states, for the period 1997–2005, the amount of waste exported among countries in the European Union (EU) almost quadrupled, indicating that individual states have made little progress toward self-sufficiency in waste disposal. The open-borders policy in the EU allows these countries to act as a single market for hazardous waste disposal and treatment. The free movement of commodities, including waste, between countries makes it difficult to follow these wastes and determine whether these shipments are problematic or not. The EEA (2009) report highlights the need for better understanding of the issue of transboundary shipments of hazardous waste.
- In 2009, the WCO conducted a multi-national inspection initiative, Operation Demeter, which targeted illicit transboundary shipments of hazardous waste. It is anticipated that these data will populate the WCO illegal shipment database to better understand the points of origin of the various waste streams being traded internationally. Until the legal hazardous waste trade is fully understood, it will be difficult to detect, interdict, and disrupt the illegal hazardous waste trade in a globally coordinated manner.

- Three global networks are currently targeting transboundary shipments of hazardous waste. The Implementation and Enforcement of Environmental Law – Transfrontier Shipments (IMPEL-TFS) is an informal network operating in the EU since 1992 that is focused on determining the scope and extent of illegal hazardous waste shipments in the EU through a rigorous cargo inspection program. Since 2008 the International Network of Environmental Compliance and Enforcement (INECE) Seaport Environmental Security Network (SESN) has operated globally to increase capacity, raise awareness, and facilitate collaboration of enforcement officials at seaports. These activities are conducted in both developing and developed countries to aid in the identification and interception of the illegal hazardous waste trade. Initiated in 2004, a regionally focused network, the Asian Network for the Prevention of Illegal Transboundary Movement of Hazardous Waste, works to increase communication and enforcement capacity throughout Asian countries. All three of these networks have confirmed that the illegal hazardous waste trade is still occurring and is still a major issue for developed and developing countries alike.

Hazardous waste is an issue of concern to the public as well as government officials. Hazardous waste sites are ranked the number one risk item by a randomly chosen lay public sample in Slimak's (2006) risk perception study of 24 environmental risk items. The experienced public, which included participants from academia, stakeholder groups, the business community, as well as interested citizens, ranked hazardous waste sites as

their number seven priority. Hazardous waste represents the public's concern with low-probability, potentially high-consequence events.

A suitable approach to this issue is not the total cessation of the exportation of hazardous waste but a more conscious effort to reduce unnecessary shipments. The ultimate objective is to increase the environmentally sound management of hazardous waste, and this may be best accomplished by out-of-country treatment and disposal. Because the decision to export waste is made at the national level and may be influenced by social, economic, political, and technological characteristics of the specific country, the interaction of these internal, national forces is examined within the collective action theoretical framework.

Perspectives from government officials, based on their experiences in implementing the Basel Convention, will also be presented for two geographic regions that continue to receive illegal waste shipments, Asia and West Africa. These officials are responsible for managing legal shipments as well as illegal shipments, when detected. The insights of these officials were obtained through an assessment of needs conducted by INECE. The responses to the needs assessment provide strategic ideas on how to overcome obstacles and improve the effectiveness of national waste management programs.

The results of this research have implications for the illegal toxic waste trade, which an interagency working group of U.S. intelligence agencies estimates nets $1-2 billion per

year (International Crime Threat Assessment, 2000). An understanding of the legal trade will help develop intelligence on the illegal trade. Interpol (2006, 2009) has found that those entities involved in the illegal waste trade are usually involved in other illegal activities and may be associated with legitimate waste trading businesses (UNODC, 2009). If it is possible for national and international entities to address the identified factors driving the export of waste, the result may be reduced volumes of hazardous waste in international trade. Any reduction in the number of legal transboundary shipments of hazardous waste will allow enforcement officials to allocate more of their limited resources toward targeting and inspecting suspect shipments, a resource-allocation strategy currently used by U.S. Customs and Border Protection through preferred shipper and importer programs (U.S. Customs and Border Protection, 2009a, 2009b).

Chapter 2: Hazardous Waste

In order to understand the transboundary trade in hazardous waste, it is important to understand how hazardous waste is defined and classified and its cradle-to-grave lifecycle. This includes understanding the industrial processes that produce hazardous waste, the amount of waste generated, where it is geographically produced, its chemical composition and hazardous characteristics, and available treatment and disposal technologies.

2.1 Definition of Hazardous Waste

Hazardous waste is an unwanted byproduct of the use of chemicals, and, if improperly managed, hazardous wastes can release toxic chemicals into the environment. Due to the different definitions of what constitutes a hazardous waste, there is a range of values given for the actual amount of hazardous waste generated. Therefore, in order to be consistent, the definition of hazardous waste contained in the Basel Convention and the waste generation and export values presented in the National Reporting Database of the Basel Convention are referenced in this research. According to the Basel Convention,

"wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law" (UNEP, 2009a, p. 6). The definition of hazardous waste takes a number of forms. It may be classified on the basis of how it is generated, what it is composed of, what danger it poses to humans, or how it is managed and treated (Figure 1). The same waste may fall under a number of classifications, further complicating the collection of global data on the amount and type of hazardous waste.

Annex 1 of the Basel Convention lists wastes to be controlled by waste stream (i.e., Y5: wastes from the production of wood-preserving compounds) and waste constituents (i.e., Y24: arsenic, arsenic compounds). Annex III lists hazardous waste characteristics (i.e., H11: toxic-delayed or chronic). Therefore wood-preserving wastes containing arsenic can be classified in multiple ways. A waste is considered hazardous if it is listed in Annex I, unless it does not display any of the characteristics of Annex III, or if it is not listed in Annex I but is declared hazardous by the national regulation of the export, import, or transit countries. Household waste is considered an "other" waste and also covered under the Basel Convention. Radioactive waste and ship-discharge waste are not covered under the Basel Convention but are covered by other international instruments (UNEP, 2009a).

Regional hazardous waste conventions, such as the Bamako Convention (Africa), take the definition of hazardous waste a little further, including the Annex I and Annex III

wastes of the Basel Convention, nationally designated wastes, radioactive wastes, and banned, cancelled, and hazardous substances for which the registration is refused or voluntarily withdrawn (Bamako Convention, 1991). The Lome IV Convention (Africa, Caribbean, and Pacific States) considers Annex I and III of the Basel Convention, household waste, and radioactive waste as hazardous (Lome IV Convention, 1995).

The Organization for Economic Cooperation and Development (OECD) defines hazardous waste as that generated by industrial activities on the basis of specific patterns of production, including radioactive waste (OECD, 2008).

In the United States, hazardous waste is defined by the Resource Conservation and Recovery Act (RCRA). First, the waste must be classified as a solid waste. The definition of a solid waste is not based on the physical form of the waste but the fact that the material is a waste. Solid, semisolid, liquid, and gaseous wastes may be classified as a solid waste. If it is determined to be a solid waste, then a determination is made whether it is listed on any of the four RCRA lists of known hazardous wastes. These lists contain wastes from nonspecific common manufacturing and industrial sources (F list), wastes from specific sectors of industry and manufacturing (K list), and discarded pure and commercial-grade unused chemical products (P List and U List). If a waste is not included on these four lists, it is considered hazardous if it exhibits one of the four RCRA characteristics, including ignitability, corrosivity, reactivity, or toxicity. In addition, RCRA-authorized states may declare state-specific hazardous wastes (USEPA, 2009).

In 2006, the European Commission revised its definition of hazardous waste to provide a common terminology that would allow more efficient management of waste within the European Community. Annex I of Directive 2006/12/EC contains a listing of 16 categories of hazardous waste, excluding radioactive waste, that replace the green (nonhazardous), amber (conditionally hazardous), and red (always hazardous) listed wastes previously used by Directive 75/442/EEC (European Commission, 2006). Many of these waste categories classify the waste as to its condition, for example, chemicals that do not meet required commercial specifications or those that are expired, adulterated, contaminated, or banned.

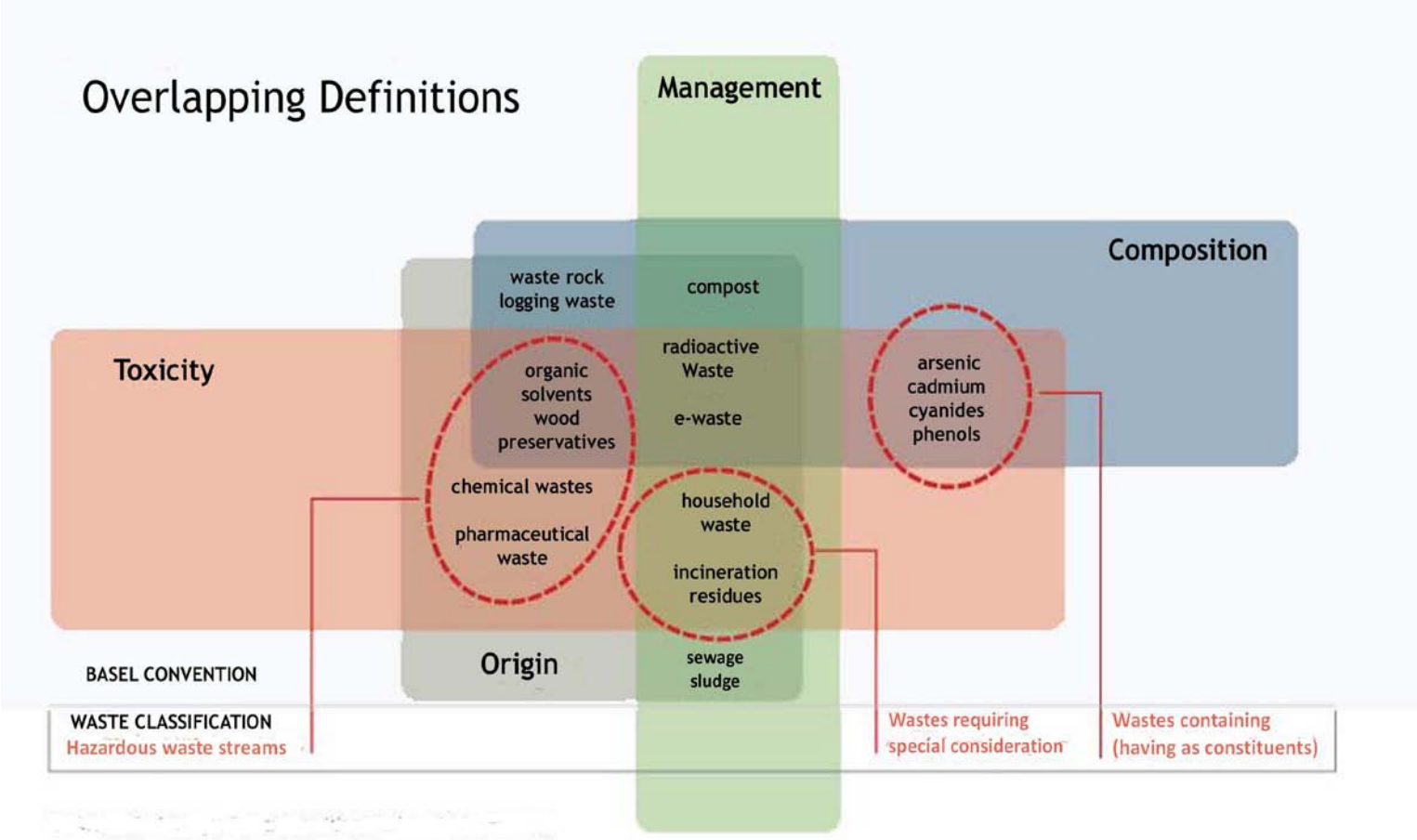

Figure 1: Overlap of Definitions for Categories of Hazardous Waste

(Basel Convention, 2010, http://www.grida.no/publications/vg/waste/page/2853.aspx)

2.2 Hazardous Waste Classification

The Basel Convention classifies hazardous waste by waste stream, waste constituents, and waste characteristics, as listed in Table 1. The exporting country for any wastes classified as hazardous is required to obtain the consent of the importing country as well as any transit countries before the shipment can occur.

Table 1: Basel Convention hazardous waste classification schemes (UNEP, 2009a)

BASEL CONVENTION HAZARDOUS WASTE CLASSIFICATION		
Waste streams to be controlled:	Waste constituents to be controlled:	Hazardous characteristics:
Medical/clinical	Metal carbonyls	Explosive
Pharmaceutical production	Beryllium; beryllium compounds	Flammable liquids
Waste pharmaceuticals	Hexavalent chromium compounds	Flammable solids
Biocides and phytopharmaceuticals production	Copper compounds	Substances or wastes liable to spontaneous combustion
Wood preserving	Zinc compounds	Substances or wastes that, in contact with water, emit flammable gases
Organic solvent production	Arsenic, arsenic compounds	Oxidizing
Heat treatment and tempering operations containing cyanides	Selenium, selenium compounds	Organic Peroxides
Waste mineral oils	Cadmium, cadmium compounds	Poisonous (Acute)
Waste oils/water, hydrocarbons/water mixtures, emulsions	Tellurium, tellurium compounds	Infectious substances
Polychlorinated biphenyls	Mercury, mercury	Corrosives

(PCBs) and/or polychlorinated terphenyls (PCTs) and/or polybrominated biphenyls (PBBs)	compounds	
Refining, distillation, and any pyrolytic treatment	Thallium, thallium compounds	Liberation of toxic gases in contact with air or water
Inks, dyes, pigments, paints, lacquers, varnish production	Lead, lead compounds	Toxic (Delayed or chronic)
Resins, latex, plasticizers, glues/adhesives production	Inorganic fluorine compounds excluding calcium fluoride	Ecotoxic
Research and development waste	Inorganic cyanides	Capable, by any means, after disposal, of yielding another material, e.g., leachate, which possesses any of the characteristics listed above
Explosive waste	Acidic solutions or acids in solid form	
Photographic chemicals and processing waste	Basic solutions or bases in solid form	
Surface treatment of metals and plastics	Asbestos (dust and fibers)	
Industrial waste-disposal-operations residues	Organic phosphorus compounds	
	Organic cyanides	
	Phenols, phenol compounds including chlorophenols	
	Ethers	
	Halogenated organic solvents	
	Organic solvents excluding halogenated solvents	
	Any congenor of polychlorinated dibenzo-furan	
	Any congenor of polychlorinated dibenzo-p-dioxin	
	Select organohalogen compounds	

2.3 Electronic Waste

A more recent and growing threat is that of electronic waste or e-waste, consisting of obsolete and unwanted electrical and electronic devices, including computers, monitors, cell phones, video and audio equipment, and appliances (Greenpeace, 2008). Many devices that were once strictly electrical now have electronic microprocessors embedded in them. Large household appliances and computer equipment accounted for 82% of this category of waste in 2000 (Babu, Parande, & Basha, 2007). Radio, cathode ray tube (CRT) TVs, and audio equipment accounted for 8% (Babu, Parande, & Basha, 2007) of the total electric and electronic waste; however, with the transition to digital TV signals, the CRT waste stream is increasing and will likely continue to increase significantly until all the analog TVs are sent to end-of-life management.

There is a wide range of toxic materials found in e-waste, including but not limited to lead, cadmium, mercury, antimony, phosphors, and brominated flame retardants. The glass in the CRT from an older television (nonflat screen) can contain up to four pounds of lead (GAO, 2008). Cell phones can contain over 40 different elements, with 23% of the weight of cell phones being attributed to various metals. There are many materials in e-waste, such as copper, tin, and indium, that can provide useful raw materials through recycling and can be a source of secondary materials and income (UNEP, 2009c). However, e-waste needs to be handled in the same environmentally sound manner as other forms of hazardous waste.

Nowhere is the confusion relating to classification of hazardous waste more pronounced than in electronic waste, or e-waste. Definitions of e-waste vary widely. The Basel Convention categorizes e-waste as hazardous on the basis of its material or chemical composition (Figure 1). Not all electronic materials are considered hazardous. The United States only regulates CRTs, such as those found in televisions and computer monitors. The European Commission lists all components, subassemblies, and consumables that are part of the electrical and electronic equipment at the time of disposal as waste (European Commission, 2002). On the corporate side, companies are articulating an even more restrictive definition. For example, Dell has stated that it will not export any nonworking electronic product for recycling, reuse, repair, or disposal (Mintz, 2009).

Worldwide, 40 million tons of e-waste were produced in 2005. The European Union estimates that only one-third of this e-waste was handled in an environmentally sound manner. The remainder may be in storage, landfilled, or illegally exported; however, only limited geographically specific data are available on this waste (UNEP, 2009c). In 2007, the U.S. Environmental Protection Agency estimated that, of the 2.25 million tons of TVs, cell phones, and computer products ready for end-of-life management, 18% was collected for recycling and 82% went to disposal, presumably in landfills. This is up from the 1997–2005 recycling rate of 15% because of the enactment of legislation requiring the recycling of e-waste by individual states (USEPA, 2010).

2.4 Hazardous Waste Generation

Hazardous waste production is one result of our industrialized society. As populations grow and incomes rise, more goods are consumed and waste production increases. The total amount of hazardous waste produced worldwide since World War II has increased 60-fold (Hackett, 1990). A total of 91 million metric tons of hazardous waste was produced by countries that reported waste generation figures to the Basel Convention in 2006, with 77 % being produced by industrialized countries (Annex VII) and 23 % by developing countries (non-Annex VII). This indicates that waste generation is no longer a problem of developed countries (Basel Convention, 2010). Approximately 10 million metric tons of the hazardous waste generated was involved in transboundary movements, with 81% going to recovery facilities and 19% going to disposal facilities (Basel Convention, 2010). Because all countries do not submit annual reports to the Basel Convention, any analysis conducted using these data should not be considered a complete accounting of total hazardous waste produced.

Hazardous wastes can be generated mostly from industrial processes but may also originate from military, agricultural, commercial, or even domestic operations. According to the European Chemical Industry Council (2006), approximately 10% of all world trade involves chemicals, with a value of approximately $2 billion. A few large multinational corporations are responsible for most of the global chemical production,

with the majority of the chemicals being produced in Japan, China, and India, followed by European Union countries and the United States. Dangerous emissions from these chemicals can be released through processing, combustion, intentional use, or leakage. Well-documented examples of these dangerous emissions include the atmospheric release of dioxin from a chemical manufacturing plant in Seveso, Italy in 1976, which required the medical treatment of over 2,000 exposed people, and the leaching of buried toxic chemicals generated by a nearby chemical plant in Love Canal, New York in the 1970s (Selin, 2010). The release of methyl isocyanate from a chemical factory in Bhopal, India killed approximately 4,000 people and seriously injured thousands more (Selin, 2010).

2.5 Geographic Distribution of Hazardous Waste Generation

To understand the hazardous waste generation by countries included in the research dataset, Table 2 lists Article 1.1.a wastes, which are the wastes listed in the annexes of the Basel Convention and Article 1.1.b wastes, which are defined by specific countries as being hazardous and are therefore hazardous according to the Basel Convention.

Table 2: Hazardous Waste Generation by Countries in Research Dataset (2006) (Basel Convention, 2010)

Hazardous waste generated in 2006, as reported in the Basel Convention National Reporting Database (metric tons)			
Country	Article 1.1.a wastes: declared hazardous according to Basel Convention	Article 1.1.b wastes: declared hazardous by national legislation and are therefore hazardous according to Basel Convention	Total hazardous wastes generated
Algeria	325,000		325,000
Andorra	936		936
Argentina	151,923		151,923
Australia	3,258,266		3,258,266
Austria	838,646		838,646
Azerbaijan	13,000*		13,000
Bahrain	38,740		38,740
Belarus	122,442	2,611,094	2,733,536
Belgium	1,034,932	1,676,244	2,711.176
Bosnia and Herzegovina	4,447		4,447
Brunei Darussalam	30		30
Bulgaria	1,158,936*		1,158,936
Chile	6,091		6,091
China	10,840,000		10,840,000
Costa Rica	1,245		1,245
Croatia	39,879		39,879
Cuba	1,253,673		1,253,673
Cyprus	50,443		50,443
Czech Republic			1,455,000
Denmark	213,055	210,752	423,807
Egypt			225,000
Estonia			6,763,532
Finland			1,129,299
France			9,610,000
Germany			18,529,000
Greece			333,155
Hungary	398,052	398,052	796,104

Ireland	720,976		720,976
Israel	328,400		328,400
Italy			5,906,000*
Kiribati	82		82
Latvia	45,047		45,047
Luxembourg	90,810		90,810
Malaysia	615,032	488,425	1,103,457
Malta	1,346		1,346
Mexico	8,000,000		8,000,000
Morocco	131,000		131,000
Mozambique	341,768	11,526	353,294
Netherlands	5,173,906	125,915	5,299,821
Norway	1,020,000		1,020,000
Poland	1,688,529	123,197	1,811,726
Portugal	199,950*		199,950
Qatar	36,235		36,235
Republic of Korea	2,621,547	1,038,099	3,659,646
Republic of Moldova	7,426		7,426
Romania	1,052,815		1,052,815
Singapore	413,000		413,000
Slovakia	533,774	132,871	666,645
Slovenia	90,909		90,909
Spain	3,228,248		3,228,248
Sri Lanka	57,889		57,889
Sweden	2,777,000		2,777,000
Ukraine	2,370,900*		2,370,900
United Kingdom	6,037,068		6,037,068
Zambia	10,622		10,622

*Amount of hazardous waste generated is unavailable for 2006; data for 2005 is listed.

According to the Basel Convention (2010), the reporting countries represent 40% of the world's population and 60% of the world's gross domestic product (GDP). As countries develop and consumption increases, the country will establish an industrial sector to help meet demands for more materials and products. As a result, waste generation will

generally increase as countries develop and industrialize, as evidenced in Asia and Latin America (Yang, 2008).

Calculating hazardous waste generation on a per capita basis is a better estimation of consumption patterns in a country than calculation on a per GDP basis, which better represents the size of the country's industrial production sector. The calculation of waste generated on a per capita basis normalizes the data and allows for the comparison of countries regardless of population size. Normalization on an economic scale, such as GDP, allows for comparison of countries at all economic levels of development. For the most part, higher-income countries will generate the most hazardous waste. Table 3 lists the top 10 countries in relation to hazardous waste produced per capita and hazardous waste produced per unit of GDP in 2006. Estonia ranks high on both scales because of the production of large amounts of hazardous wastes from the fuel used in the country's power plants. The inclusion of countries such as Mozambique and Cuba on the GDP listing may be due to specific industries in these countries that produce large amounts of waste (Basel Convention, 2010). The top hazardous waste generators, listed in Table 3, are all included in the research dataset.

Table 3: Top Hazardous Waste Producers, by capita and by unit GDP (Basel, 2010)

Generation of hazardous waste per capita (kg/person)	Generation of hazardous waste per unit of GDP (ton/million US$)
Countries listed from higher to lower ranking	
Estonia	Estonia
Netherlands	Belarus
Sweden	Mozambique
Belarus	Cuba
Belgium	Sweden
Germany	Netherlands
Norway	Ukraine
Finland	Belgium
Luxembourg	Germany
Ireland	Slovakia

2.6 Hazardous Waste Management

Of the hazardous waste shipped to another country in 2006, 81% was destined for resource recovery, recycling, reuse, or reclamation. The remaining 19% was shipped for final disposal (Basel Convention, 2010). The Basel Convention distinguishes between processes that lead to resource recovery, recycling reclamation, direct reuse, or alternative uses and those operations that do not.

In order to conserve natural resources, it is preferable to recover, recycle, and reuse components in waste, provided that environmentally sound management practices are incorporated into the respective processes. Figure 2 shows the various possible

components of a country's waste management scheme (Asante-Duah & Nagy, 1998). Waste export, the subject of this research, is only one option of many available to generators of hazardous waste. The Basel Convention (UNEP, 2009a) lists options for reutilizing the waste and avoiding disposal including the following:

- use as a fuel (other than in direct incineration) or other means to generate energy,
- solvent reclamation/regeneration,
- recycling/reclamation of organic substances, metals, and other inorganic materials,
- regeneration of acids or bases,
- recovery of components used for pollution abatement or catalysts,
- used oil re-refining, and
- land treatment resulting in benefit to agriculture or ecological improvement.

Disposal options, not leading to recovery, recycling, reclamation, or reuse, include the following:

- landfill (direct deposit on land or in specially engineered facility),
- land treatment,
- deep injection,
- surface impoundment,
- release into water body (may include ocean/sea),
- biological treatment,
- physiochemical treatment,
- incineration on land or at sea, and
- permanent storage.

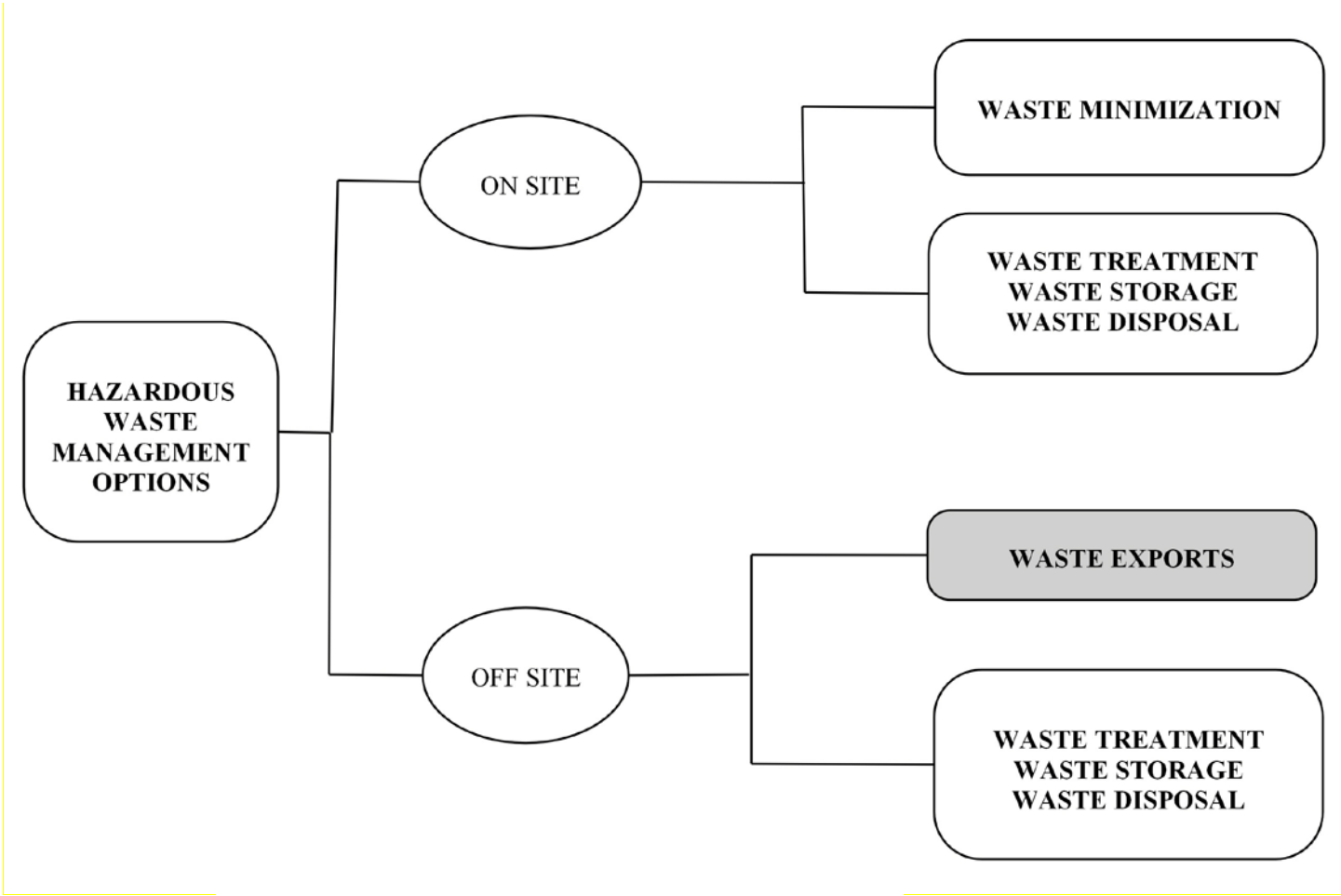

Figure 2: **Possible components of a country's waste management scheme (Asante-Duah & Nagy, 1998)**

2.7 Characteristics of Hazardous Waste Exports

According to the Basel Convention, there are 11 categories of waste that account for most of the transboundary shipments of hazardous waste (Basel Convention, 2010), as shown in Table 4.

Table 4: Hazardous Waste Exports by waste type for 2004-2006 (Basel, 2010)

Export of hazardous waste by waste type for 2004-2006		
Waste type	**Waste description**	**Average percentage 2004-2006**
Waste from waste disposal	Effluent sludges, treatment residues	13%
Lead	Lead acid battery components	7%
Zinc compounds	Ashes or drosses, arc-furnace residues, zinc-containing batteries	7%
Oil/water mixtures		5%
Surface treatment waste	Sludges from metal treatment, metal pickling acids	2%
Acids		2%
Waste oil		2%
Nonhalogenated solvents	Solvents not containing fluorine, iodine, bromine, or chlorine	2%
Wood preservatives		2%
Article 1.1.b wastes	Determined to be hazardous through national legislation	36%
Other hazardous wastes		14%
Hazardous waste comprises an estimated 90% of all waste reported to the Basel Convention; the remaining 10% is listed as “other waste”.		

Alternatively, wastes may also be classified on the basis of the characteristics exhibited, as listed in Table 5.

Table 5: Exports of Hazardous Waste by Waste Characteristic for 2006 (Basel, 2010)

Transboundary shipments of hazardous waste (2006), listed by Annex III Hazardous Characteristic, in metric tons	
Waste characteristic	**Amount (metric tons)**
Explosive	9,652
Flammable liquid	330,870
Flammable solid	111,462
Spontaneously combustible	15,367
Flammable gas emitter when exposed to water	89,822
Oxidizing	37,705
Organic peroxides	106
Poisonous (acute)	569,631
Infectious substances	4,782
Corrosives	895,537
Liberates toxic gas when exposed to air or water	102,746
Toxic (delayed or chronic)	863,707
Ecotoxic	1,633,565
Capable of releasing a substance with the above characteristics	750,063
Unspecified or not reported	5,837,638
TOTAL	11,252,383

The effective management of hazardous waste is necessary to prevent endangerment of human health and the environment. The process necessary to manage a specific waste stream will depend on the waste characteristics and composition of the material.

Transboundary shipments of hazardous waste should be minimized and only occur if a higher level of environmentally sound management, than is available in-country, can be achieved.

Chapter 3: Literature Review

3.1 Scope of the Legal Hazardous Waste Trade

The transboundary shipment of hazardous waste has become a global concern (Clapp, 2001; Kamuk & Hansen, 2007; Montgomery, 1995; O'Neill, 1998; Pellow, 2007). Much of the hazardous waste trade is between industrialized nations that have the environmental regulations and infrastructure in place to properly handle the material, if all legal requirements are met (Basel Convention, 2010). Annual national export data for 2004-2006 indicate that 86% of all shipments were among industrialized countries, as presented in Table 6 (Basel Convention, 2010). Countries that have ratified the Basel Convention are classified as either Annex VII countries, which includes developed countries including members of the Organization for Economic Cooperation and Development (OECD), European Community, and Liechtenstein, or non-Annex VII countries, which includes developing countries or countries in transition. There is currently an amendment to the Basel Convention pending that will ban all trade in hazardous waste from Annex VII to non-Annex VII countries.

Table 6: Transboundary shipments of waste for 2004-2006 as reported to the Secretariat of the Basel Convention (Basel Convention, 2010)

Country Classification	Metric tons of hazardous and other waste*			Total number of shipments	Percentage of total waste shipped (%)	Change 2004/ 2006 (%)
	2004	2005	2006			
Annex VII to Annex VII	7,901,517	8,136,444	10,066,349	5,763	86%	27%
Non-Annex VII to Annex VII	114,855	177,320	227,845	291	2%	98%
Non-Annex VII to Non-Annex VII	1,201,169	736,841	803,323	52	9%	-33%
Annex VII to Non-Annex VII	570,391	283,667	154,866	31	3%	-73%
TOTAL	9,787,932	9,334,272	11,252,383		100%	15%

Note: Annex VII countries include developed countries (OECD, European Community and Liechtenstein). Non-Annex VII countries include developing countries and countries in transition.
*Different countries may be included in the data totals for each year, dependent on which countries reported that year.

In Table 6, it is encouraging to note that the shipments between developed countries and shipments from developing to developed countries showed significant increases in the 2004-2006 time frame. Also encouraging is the drop in shipments among developing countries and from developed to developing countries. The current percentage of these shipments is a significant improvement from the early 1990s, when these developed to developing country waste shipments accounted for 20% of the total hazardous waste

trade (Hackett, 1990). The waste trade from developed to developing countries has historically been of particular concern, as many developing nations do not have the infrastructure, technology, and regulatory enforcement in place to handle toxic wastes safely, and these materials have caused and continue to cause severe environmental and human health problems (Clapp, 2001; Selin, 2010). The numbers reported in Table 6 represent only the legal trade, as reported by countries to the Secretariat of the Basel Convention. As the number of waste shipments destined for disposal has decreased as a result of increased regulatory control, the number of shipments labeled for recycling, reuse, or as "second-hand" goods has increased. Targeted cargo inspections have shown that illegal shipments of waste are sometimes mislabeled under these categories to avoid regulatory scrutiny (INECE, 2010a).

3.2 Scope of the Illegal Hazardous Waste Trade

The global waste trade can be divided into those shipments that are legal under the Basel Convention and those that are not. The Basel Convention requires annual national reporting on transboundary shipments that is compiled by the Secretariat of the Basel Convention (UNEP, 2009b). Exact figures on the number of illegal shipments are not known, as many of these shipments are only detected after significant environmental or human health damage has occurred or as the result of targeted inspections. It is estimated that the illegal dumping of waste nets $1–2 billion per year (International Crime Threat Assessment, 2000). Certain geographic areas are known as target destinations for these

illegal shipments, including Asia and West Africa (Clapp, 2001, Shinkuma & Huong, 2009).

An illegal hazardous waste shipment is one that does not follow the provisions of the Basel Convention. According to Article 9 of the Basel Convention, a shipment is considered illegal if it

- does not provide advance notification,
- does not have the consent of the receiving country,
- has a consent that was obtained through fraud,
- has misrepresented waste characteristics, or
- was deliberately disposed of in an illegal manner with disregard to international law (UNEP, 2006).

There has been much discussion about the illegal trade in hazardous waste, particularly the shipment of waste from wealthy countries to poor countries (Clapp, 2001; Singh & Lakhan, 1989). According to Sanchez (1994), less developed countries were "being invaded by extensive exports and dumping of tons of hazardous waste from industrialized nations" (p. 139). He notes a shift by Third-World countries that were initially willing to accept the risk associated with the importation of hazardous waste because of the income these shipments provided but have since banned all waste imports although some of these countries may not have the enforcement capability to prevent these imports. Pellow (2007) states that, although corporations may look more environmentally responsible, the

more hazardous operations are actually being shifted to less developed countries that may have less stringent environmental regulations. As the public scrutiny of transboundary hazardous waste shipments increased and developing countries began rejecting these shipments, transnational corporations began locating their hazardous production industries in these countries (Frey, 1998). Examples of some of the hazardous industrial operations that have been exported to developing countries include asbestos processing (Johns-Manville), dye manufacture (Montedison), chromate processing (Bayer), pesticide production (Diamond Shamrock, Union Carbide), and steelmaking (Nippon Steel) (Frey, 1998). This practice allows the hazardous wastes to be managed near the point of generation without the regulatory scrutiny that accompanies transboundary shipments. Other benefits to these transnational corporations include lower production costs, lower labor costs, and reduced regulatory oversight, indicating that the movement of hazardous industrial production facilities to less developed countries may be driven by multiple forces. Although it may seem that this practice meets the Basel requirement for management of hazardous waste as close as possible to the point of generation, these countries may not have developed environmentally sound waste management practices, an important component of effective compliance. The maquiladora program, instituted by Mexico in 1965 to encourage the location of foreign-owned industries in the Mexican border zone, is an example of this transfer of industrial processes. The same transfer of industries is currently occurring in China and South East Asia, where labor costs are even lower relative to the Mexican wages. The 1984 Bhopal, India disaster, where thousands of Indians died as a result of a chemical release from the Union Carbide plant located

there, is an example of the consequences that can occur from such plant relocations (Selin, 2010).

The illegal transboundary trade in hazardous waste may actually be driven by the stringent environmental regulations in the industrialized countries, which increases the cost of in-country legal disposal, making illegal disposal in countries with weaker regulations more attractive to some waste traders (Clapp, 2001). Analyzing pre-1995 data, Montgomery (1995) does not see a pattern of illegal transboundary shipments. Others researchers disagree and state that the illegal waste trade continues to be a significant problem (Clapp, 2001; Greenpeace, 2008; IMPEL, 2006; INECE, 2010a, 2010b; Krueger, 1998, 2002; WCO, 2009).

Much of the data on illegal shipments of hazardous waste to developing countries is from the 1980 to 1990 time period, when the Basel Convention was under development and there was much interest in quantifying the extent of the problem. In order to confirm that these shipments are still occurring and are still a concern to government officials and the public, the researcher conducted a review of media and government sources for the 2000-2009 timeframe. The results indicate that this illegal waste trade is still occurring, as indicated by the cases and data presented in Appendix A.

In order to determine the current scope of illegal shipments, joint enforcement actions were conducted at six European seaports in 2003-2004 under the IMPEL-TFS project.

Currently, 15% of all shipments in the European Union (EU) are waste shipments. During this enforcement action, 508 shipments of waste were inspected. Approximately 20%, or 103 shipments, was found to be illegal, taking place without the required documentation (Isarin, 2005). Misrepresentation of the waste on the documentation is one method of disguising illegal shipments of hazardous waste, for example, describing hazardous electronic waste as nonhazardous plastic waste or scrap metal (INECE, 2010a). In 2005, IMPEL-TFS conducted another round of inspections and reported that 48% of the shipments involved in joint enforcement operations at 17 European ports were illegal on the basis of inspections of the cargo and associated documentation (IMPEL, 2006). A targeted inspection effort of the World Customs Organization (WCO) confirmed the interception of over 120 illegal hazardous waste shipments in two Asian countries during a seven-month period in 2007 (WCO, 2009). A second round of inspections by Customs officials uncovered similar results. These incidents confirm the Basel Convention's statement that illegal traffic in hazardous waste is still very common in all corners of the world (UNEP, 2006). Of the 74 targeted inspections conducted during the 2010 the International Network for Environmental Compliance and Enforcement Seaport Environmental Security Network (INECE SESN) international inspection event, 53% were determined to have infractions to applicable regulations (INECE, 2010a).

As Mostafa Tolba stated in 1992, during his last year as Executive Director of the United Nations Environment Program (UNEP), "Hazardous waste will always follow the path of

lower costs and lower standards," and this statement is still true today (Clapp, 2001, p. 36).

The targeted inspection events described above indicate that the percentage of illegal hazardous waste shipments ranges from 20–53%; however these inspection events are limited by time and geography and cannot capture the full breath of the illegal waste trade. The percentages of actual illegal shipments may be substantially higher than recorded or estimated for two reasons. First, illegal shipments are only reported when detected. Widespread corruption at ports, with poor regulatory oversight, can allow illegal shipments to enter undetected (Alabi, 2003). Second, it is likely that there are shipments that are denied entry at a port, but the incidents are not publicly reported or communicated to other countries in the region. There are a number of ways illegal shipments can gain entry to a country, including the following:

- misrepresentation or mislabeling of the waste as nonhazardous,
- falsification of informed-consent papers prior to import,
- concealment of the waste,
- commingling of the hazardous waste with non-hazardous municipal waste,
- identification of the waste as bound for recycling rather than disposal, or
- bribery of enforcement officials.

3.3 International Response to Illegal Shipments

Initial directives and recommendations on transboundary shipments of hazardous wastes were published in 1984 by the OECD and the European Commission (EC) and were applicable to nations in those organizations (Clapp, 2001). Two years later, both the OECD, representing developed countries, and the EC revised their documents to include waste shipments to developing countries, adding an advance notification and consent requirement. In 1985, at the request of Senegal, Switzerland, and Hungary, discussions were initiated to address the issue of transboundary trade of hazardous waste at the international level (Clapp, 2001).

There were two egregious examples of illegal transboundary dumping that highlighted the issue of transboundary shipment of hazardous waste and prompted international action. In 1986, the *Khian Sea* picked up 15,000 tons of municipal incinerator ash, containing toxic metals and dioxins, from Philadelphia, PA. Two thousand tons of the waste, labeled as fertilizer, was dumped on a beach in Haiti. After the mislabeling was discovered, Haiti demanded that the captain of the *Khian Sea* remove the waste, but the ship left port in search of other off-loading locations. After being denied entry into Latin American, Caribbean, Asian, and African ports, the ship wandered the seas for 16 months, during which time the rest of the hazardous waste disappeared, presumably dumped at sea. During its journey, the ship changed its name twice to conceal its identity (American University, 1992-95; Clapp, 2001).

The second incident occurred in 1988 and involved a ship named *Karin B.* This ship dumped an estimated 6,000 drums of highly toxic industrial waste in Nigeria. The waste containers, originating in Italy, leaked, causing a number of villagers to become seriously ill. The Nigerian government demanded that Italy take the waste back, a request that Italy initially refused. The waste was loaded back on the ship and was denied entry at six other European ports before Italy finally accepted the return of the waste (Cooke & Chapple, 1998; Vir, 1989).

In 2008, Darst and Dawson posed the question, "Given the ample incentives and opportunities for consumers, firms and governments to export environmental hazards to other countries, why would they choose *not* to do so?" (p. 20). The authors cite three reasons, including the following:

- opposition of the importing countries,
- opposition by nongovernmental organizations (NGOs) to all transboundary shipments, and
- support for more regulatory control by waste treatment and disposal firms to support their competiveness in the tightly regulated market.

All three of these reasons brought about the development of the Basel Convention to control the transboundary movement of hazardous waste.

3.4 The Basel Convention and Its Limitations

During the mid 1980s, ongoing OECD and EU discussions focused attention on the need for international action and led to the enactment of the Basel Convention, which is the multilateral environmental agreement (MEA) that regulates the international hazardous waste trade.

The Basel Convention was made available for signature in 1989 and came into force in 1992, after the minimum number of 20 countries ratified the treaty. The first ten years (1989–1999) were devoted to controlling the transboundary shipment of waste through a system of prior informed consent between exporting, importing, and transit countries, as well as creating the criteria for environmentally sound waste management practices. The goal of the second ten years (2000-2010) is minimization of transboundary shipments of hazardous waste through full implementation and enforcement of treaty commitments (UNEP, 2008a, 2008b, 2008c). The three key objectives of the Basel Convention are

- minimization of the amount of waste generated,
- management of the waste as close as possible to its point of generation, and
- reduction in the transboundary movement of hazardous waste (Basel Convention, 2010).

The Basel Convention prohibits the export of hazardous waste for disposal from Annex VII to non-Annex VII countries and only allows transboundary shipments of waste to

non-Annex VII countries if the wastes are destined for recycling or reuse. Most of the transboundary shipments are between Annex VII countries and are conducted for the purposes of disposal or recycling/reuse. Parties to the Basel Convention are required to self-report amounts of hazardous waste imported and exported annually, as well as any accidents involving transboundary hazardous waste shipment.

As of 2010, 175 parties have ratified the Basel Convention. All countries of the OECD have ratified the Basel Convention, except the United States. Currently, the U.S. is considering ratification of the Basel Convention; however the Basel definition of hazardous waste is more comprehensive than the current Resource Conservation and Recovery Act (RCRA) definition, requiring that RCRA be amended to allow full implementation of the Basel Convention. Unlike some countries, the United States traditionally has implementing legislation in place prior to ratification of international conventions. It is not clear at this time when, or if, ratification will occur. Although the United States is an active participant and supporter of activities of the Basel Conference of Parties and is a member of the Basel Partnership for Action on Computing Equipment (PACE), it does not have the right to vote.

Today, international waste shipments are governed by three categories of agreements:

- Basel Convention (in force since 1992),
- *OECD Decision C (2001) 107 Final* as amended by *C (2004) 20* for waste shipments for recovery (European Commission, 2004), and

- bilateral and regional agreements between specific countries (registered under the Basel Convention). As of February 2011, nine multilateral/regional agreements and 13 bilateral agreements have been submitted to the Secretariat of the Basel Convention in accordance with Article 11 of the Convention. These agreements allow non-Basel countries to trade waste with Basel countries.

The United States currently trades hazardous waste through a multilateral agreement with the OECD and through bilateral agreements with specific countries. Basel countries are not allowed to trade with non-Basel countries; therefore, in order for the United States to trade with a Basel country, a specific agreement must be in place.

The negotiations leading up to the initial signing of the Basel Convention in 1989 were very contentious. The NGOs and the African nations felt the language of the proposed convention was too weak, which was countered by the opposite belief of major industrialized countries, including Germany, Japan, the United Kingdom, and the United States, that the language was too strong (Kummer, 1992). Because the final language was based on a series of compromises, the Basel Convention is not without limitations.

O'Neill (1998) raises the issue that the Basel Convention may actually be counterproductive to halting illegal waste shipments through

- the absence of effective monitoring and enforcement,
- its application only to international movements of waste, and

- its failure to address the root of the problem, hazardous waste generation, through regulatory targets.

To this list of deficiencies, Clapp (1994) adds

- lack of provisions to stop shipments without prior consent,
- lack of clear definition for hazardous waste and environmentally sound management,
- exclusion of radioactive waste,
- allowing countries to implement bilateral waste import/export agreements with non-OECD countries,
- no liability provisions should damage occur as the result of a shipment, and
- no incentive for reducing the amount of hazardous waste produced.

Like other multilateral environmental agreements such as the 2001 Stockholm Convention on Persistent Organic Pollutants and the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade, the Basel Convention has no supranational enforcement capacity. It is dependent on the individual national regulatory programs to provide effective enforcement, as well as legal and administrative infrastructure (Kummer, 1992). Developing or transition countries often do not have the environmental infrastructure in place to effectively enforce the Basel Convention. This lack of enforcement capability is not unique to multilateral environmental agreements but is a common deficiency of many international agreements. Button, Clarke, Palubinskas, Stough, and Tibault (2004)

discuss a similar situation where the enforcement of compliance with the International Civilian Air Organization (ICAO) safety standards lies within each sovereign nation. ICAO's efforts to achieve global compliance with standards will be discussed further in Section 9.3.2 as a possible model for achieving greater compliance with the Basel Convention,

Absence of mechanisms for assigning cross-jurisdictional liability resulting from a lack of international governing authority, different national waste definitions globally, and the absence of a clearinghouse of information on wastes in transit continue to make the enforcement of the Basel Convention difficult (O'Neill, 1998). Although individual countries may have regulations governing the import and export of hazardous waste, these regulations are only as effective as their level of enforcement. Murphy (1994) suggested that a liability and compensation scheme should be incorporated into the Basel Convention to recover costs from the generators or exporters when disposals do not go as planned. The liability and compensation scheme was adopted in 1999 but as of February 2011 does not have the required number of ratifications to put the amendment into force (UNEP, 2008c). This scheme would put the responsibility on the notifier and requires an obligation for preventive measures.

Because of the failure of the Basel Convention to prevent shipments of hazardous waste to developing countries, a number of other regional MEAs was promulgated to try and fill the gap. The Bamako Convention on the Ban of Import into Africa and the Control of

Transboundary Movement and Management of Hazardous Wastes within Africa (Bamako) was signed by all 51 members of the Organization for African Unity in 1991 (Bamako, 1991). Many African states initially refused to sign the Basel Convention stating that

- it did not go far enough in addressing the handling of shipments of mixed hazardous and radioactive waste,
- it failed to sanction the importing country if it failed to provide adequate waste disposal, and
- it did not prevent the forgery of consent documentation or bribery of port officials.

Bamako bans all hazardous waste imports into member countries. However, as with the Basel Convention, enforcement is in the hands of each individual country, which may have limited capacity to implement all the provisions of Bamako. A drawback of Bamako, as seen by some, is that it does not allow importation of materials for recycling, which, if done in an environmentally sound manner, can provide valuable raw materials and revenue for developing countries (Ovink, 1995; UNEP, 2009c). As of June 2008, the Bamako Convention has not convened a meeting of the parties (United Nations, 2008).

An additional MEA, the Lome IV Convention, was developed in 1990 to close the Basel Convention gap and ban all hazardous waste shipments to African, Caribbean, and Pacific states from the European Community. The countries signing this convention also

agreed not to accept waste from non-European sources, such as intra-Africa hazardous waste. Unlike Bamako, Lome IV does not prohibit shipments of hazardous wastes bound for recycling (Lome IV Convention, 1995).

The Basel, Bamako, and Lome IV Conventions all have two major drawbacks. First, none of these MEAs have a definition of what comprises the "environmentally sound manner" for the handling of hazardous waste that countries are required to certify they have prior to importation. Second, all three MEAs require the individual countries to provide for the effective enforcement of the Conventions (Gray, 2003). Whether or not these additional conventions have been a significant factor in reducing transboundary shipments of hazardous waste has not been determined to date.

3.5 Compliance with the Basel Convention

It is important to be clear on what compliance entails. Participation in a multilateral environmental agreement does not equate with compliance. When countries ratify an MEA, it is a signal of intent to comply with all provisions of the MEA. This requires that the country have in place the implementing regulations that are necessary to enforce compliance with the provisions of the treaty. Enforcement may be costly to provide. Some countries may not have the ability to provide effective enforcement as a result of corruption, lack of a democratic process, lack of political will to develop a waste management program, or other economic priorities. A country may sign an agreement

because such an action provides some benefit to the country, which is now a part of an international regime, a concept that is explored in Section 3.8.1. On the other hand, a country may be willing to sign the agreement when it has no intention to comply through development and enforcement of regulations (Levy, 1995).

Administration of the Basel Convention is conducted through the Secretariat of the Basel Convention, an organization located within the UNEP. The Basel Convention embodies a code of conduct that is reached through consensus, to be acceptable and equitable to the largest number of countries. Norms of behavior are set out in the Basel Convention, and each country is expected to incorporate these norms into its implementing legislation and provide for enforcement.

One mechanism through which compliance with the Basel Convention can be determined is through the required annual reporting, which documents the amount of exported hazardous waste, as well as measures taken to reduce these shipments. The publishing of annual national data is designed to increase the transparency of a country's compliance in relation to the reduction of transboundary shipments. However, there is currently no mechanism by which the Secretariat of the Basel Convention can verify the data submitted by the countries. The Basel Convention does not contain any authority to enforce national compliance, playing only a facilitating role in compliance issues.

One of required norms mandates that countries treat or dispose of hazardous waste as close to the place of generation as possible, a term that is not further defined, leading to reduced transboundary shipments. There are valid reasons for the export of hazardous waste, including a country's lack of capacity in environmentally sound management (ESM) treatment and disposal facilities, higher treatment and disposal costs in one country than another for comparable ESM facilities, and geographic closeness of treatment and disposal options in another country, resulting in lower transportation costs. Exporting hazardous waste to obtain lower cost attributable to less environmental scrutiny or non-ESM treatment/disposal is not a valid reason.

The number of transboundary shipments of hazardous waste for disposal and recovery has increased almost fourfold in the EU during the period 1997–2005 (European Environment Agency, 2009). However, it may be that some of these wastes are being transported to a facility that can provide a greater level of treatment, which would increase the environmentally sound management of these wastes. The current method of data collection on these shipments does not allow determination of the reason for export (European Environment Agency, 2009). The Basel Convention reports a 15% increase in the amount of hazardous waste that was involved in transboundary shipments during the 2004–2006 period (Basel Convention, 2010).

Illegal shipments of waste continue to arrive in the ports of developing countries, which lack environmentally sound management capabilities, indicating that transboundary

shipments of hazardous waste are still occurring for the wrong reasons. For example, the Nigerian National Environmental Standards and Regulations Agency (NESREA) estimates that 500 containers of hazardous waste enter Nigerian ports every month (allAfrica.com, 2010).

3.6 Factors Driving Exportation of Hazardous Waste

As shown in Table 6, the overwhelming majority of transboundary shipments of hazardous waste occurs between developed member states, and there has been less research conducted into hazardous waste trade among wealthier nations (Montgomery, 1995; O'Neill, 2000). Identification of the factors that drive a country to legally export hazardous waste may shed light on the incomplete picture of illegal waste trade. The United Nations Office on Drugs and Crime (UNODC) reports that legitimate companies may be involved in illegal hazardous waste trafficking to avoid the high cost of disposal in developed countries (UNODC, 2009).

There are two approaches to identifying factors driving the hazardous waste trade. Most of the approaches to date have focused on helping importing countries both develop and enhance environmental enforcement capabilities to better target, inspect, and interdict illegal waste shipments. On the basis of discussions with government officials in West Africa and Asia, the researcher has noted that these efforts can be effective if incorporated into the legislative and administrative frameworks of the countries, but

many times these efforts provide short-term progress that is unsustainable because of enforcement personnel turnover, corruption, change in governance, lack of capacity, and low levels of funding for environmental programs. This end-of-the-pipe solution requires the importing country to be the last line of defense against illegal waste shipments. In many cases the recipients of these illegal shipments are the least equipped to deal with the problem.

A review of the literature, outlined in Table 7, shows that a number of researchers have proposed various reasons for why transboundary shipments of hazardous waste occur although little quantitative analysis has been conducted to support these statements.

In 1985, the OECD discussed reasons for transfrontier movements of hazardous waste.

- Internally, as control over hazardous wastes increases, the cost of internal treatment and/or disposal increases, and previous disposal options may no longer be economically feasible. For example, if a previously landfilled waste must now be incinerated, which is a much more expensive disposal method, it may be less expensive to ship the waste to a country that still allows landfilling.
- Externally, increased globalization of trade with decreasing customs controls within trading blocs may facilitate transfrontier trade. This observation is truer today with the institution of open borders between countries in the EU (European Environment Agency, 2009).

- Individual industrial firms seeking to minimize their operating costs will seek out the least expensive waste management options, which may lie outside their national borders. There are a number of reasons for this.
    - More efficient technology in another country may make disposal less expensive.
    - An importing country may take advantage of economies of scale by providing ESM for waste for a large industrialized area.
    - The ESM treatment/disposal facility in another country may be closer to the source of the waste generation than those available in the exporting country.
- There are no treatment or disposal facilities available in the generating country.
- Multinational companies may choose to consolidate all their waste at a single facility that may not be located in the generating country.
- Countries with less stringent regulatory controls may offer less expensive disposal options.
- Transport by ship can be less expensive than by rail or truck, allowing the waste to travel longer distances in a more cost-effective manner (OECD, 1985).

Although the amount of waste that is shipped across international borders is small in relation to the amount of waste handled within national borders, the transported waste has the potential to cause serious threat to human health and the environment if not handled properly.

Singh and Lakhan (1989) give an early review, pre-1989, of the waste trade, listing actual or proposed waste shipments and showing an increase in shipping to developing countries as stronger waste regulations came into force in the U.S. and Europe. Many of the early recipients of these shipments were less developed countries, particularly in West Africa. Singh and Lakhan reaffirm that the reasons stated by OECD (1985) control why a country chooses to export waste and add the reality that some corporations may decide to dispose of their wastes in countries with lesser regulatory requirements.

Clapp (1994, 2001) confirms Singh and Lakhan's conclusions and emphasizes the connection of world economy to the environment, focusing on the transfer of waste from rich countries to poor countries. Currently, the Basel Convention prohibits the shipment of hazardous waste for disposal to non-Annex VII (non-OECD) countries, which are usually less developed than the more developed/industrialized Annex VII (OECD) countries. Only wastes bound for recycling are allowed to proceed legally, and identification of illegally labeled shipments has proven to be a difficult enforcement issue. Kummer (1992) points out that every country has the sovereign right to ban the import of hazardous wastes. Given this restriction, Clapp (2001) lists a number of reasons for this trade, including the following:

- globalization of the world economy setting up global trade and investment networks that make it easier for countries to transfer the hazards,
- lack of financial resources to properly address the problem,

- one waste trade trend stopping as another is initiated to continue circumventing national and international controls,
- growing levels of international debt and the appeal of drawing in foreign capital through participation in the hazardous waste trade,
- domestic political and institutional weakness, and
- fluidity of trade in the global marketplace.

Montgomery (1995) takes a contradictory view of the waste trade, stating that the data do not show there is a significant north-south waste trade occurring and that the hazard is not as great as reported. At the time Montgomery performed his analysis, reliable data on hazardous waste shipments were difficult to find. Available data referred only to legal shipments and did not contain data for developing and middle-income countries as a result of inconsistent reporting. It is interesting to note that, fourteen years later, these problems still plague the hazardous waste international trade dataset. Montgomery examined data from UNEP, which compiles data from national databases; however these data were difficult to compare because of the use of different national definitions for hazardous waste. The data for the less developed countries were obtained from Greenpeace, who obtained the data from governmental and nongovernmental sources, as well as from its own investigations. Admitting that the data is not "impeccable", Montgomery concludes that there is no waste trade crisis and no verification that rich countries are dumping waste on poor countries, therefore making the proposed Basel Ban on waste exports to non-OECD countries unnecessary (p. 20).

Granados and Peterson (1999) seek to develop hazardous waste indicators to assist decision makers in developing waste management policy. The authors confront the difficulty posed by different national definitions of hazardous waste and poor data available on import/export and disposal. These indicators focus on specific hazardous waste-related and technology factors and not on socioeconomic, geographic, or political factors. The authors recognize that there are currently limited data being collected nationally and internationally to allow the use of the proposed indicators.

O'Neill (2000) takes a different approach and looks at the transboundary waste trade between rich nations. O'Neill qualitatively looks at why developed countries accept the risks associated with the import of waste, focusing on Great Britain, Germany, France, Australia, and Japan. O'Neill determines that type of governance, as identified by the level of decentralization, amount of public access in the policy process, and extent of flexibility in policy formulation, is the main driving force behind whether or not a country will import waste. O'Neill believes that a race to the bottom occurs in the legal and illegal hazardous waste trade because of the high cost involved in siting new disposal facilities and the opposition to these facilities, all of which encourage waste to be exported to countries with weaker environmental policies.

Krueger (2002) posits that economic drivers are the key to the waste trade; cheaper disposal costs are the main cause for the exporting nation, whereas the potential for revenue from the recycling, reuse, or recovery of the waste is important for the importing

nation. He points out that these waste residues can provide valuable secondary materials. The public opposition to siting new hazardous waste disposal facilities, or the "not-in my-backyard" (NIMBY) syndrome, contributes to a country's decision to export a percentage of its waste.

Pellow (2007) states that there are four reasons why both the shipment of hazardous waste and the generation of hazardous waste have shifted to politically and economically vulnerable communities. First, there is a large increase in the production of hazardous waste, partnered with more stringent regulations that make disposal more expensive. Second is the willingness of economically disadvantaged countries to accept payment to dispose of hazardous waste. Third is economic globalization that requires countries to cut costs and increase profits or fail, directing wastes to countries offering the lowest waste management costs. The fourth reason for the global waste trade is linked to environmental injustice, which embodies the belief that the dumping of hazardous waste in poor communities is an acceptable practice. Unless the receiving country can provide a higher level of environmentally sound management not available to the exporting country, the waste should not be exported.

With regard to a nonparty to the Basel Convention, Taiwan exports much of its hazardous waste as a result of lack of in-country treatment and disposal facilities. In an attempt to understand and better control the waste import/export drivers at the national level, Hsing, Wang, Chiang, and Fang (2004) propose implementation strategies such as transferring

waste treatment technologies from other countries to Taiwan, encouraging waste minimization programs in local industries, and increasing domestic capability to treat waste, all of which will ultimately lead to effective waste management programs in Taiwan. Financial considerations and environmental pressures are the two predominant reasons why countries export waste (Hsing, Wang, Chiang, & Fang, 2004). Secondary materials, including some hazardous wastes, are desirable to the industrial sector as a source of raw materials, coupled with lower cost, energy savings, and greater ease of acquisition. According to the authors, "waste trading has become an important activity and cannot be ignored, especially in a country without sufficient resources" (Hsing et al., 2004, p. 330). Fan, Chang, Ni, and Lee (2005) also address the waste management issue in Taiwan and, as part of a self-monitoring project, investigate the countries that are primary importers of its hazardous waste. These countries include the United States, China, Belgium, France, and Finland, which handle more than 80% of Taiwan's waste. The authors see the EU emerging as a single unit, through which waste can be transported freely and treatment plants are sited and evaluated on the basis of benefit to the EU, not a specific country. The EU open-borders concept changes the geopolitical context of the transboundary shipment issue.

The European Environment Agency (2009) lists cost, both in differential prices for treatment and disposal, as well as variances in national waste taxes, and the lack of available treatment or need for a specialized treatment as the drivers for import and export of hazardous waste. The report also acknowledges that the EU open-borders

policy is increasing the number of transboundary shipments of hazardous waste as the EU acts as a single market.

3.7 Potential Predictors of Hazardous Waste Export

The literature discussed above presents numerous reasons why countries export their waste rather than manage it within their national borders. Table 7 is a listing of the variables that were identified through an analysis of the hazardous waste literature. Figure 3 presents a predictive model of the relationships of the influencing factors to the outcome factor, expressed as a percentage of hazardous waste exports which represents compliance with the Basel Convention. Descriptions of the predictive variables examined in this research are presented in Chapter 4.

Table 7: Factors leading to the export of hazardous waste as reported in the literature

	OECD, 1985	Singh et al, 1989	Clapp, 1994	Montgomery, 1995	O'Neill, 1998	Krueger, 1998	Hsing et al, 2004; Fan et al, 2005	European Environment Agency, 2009
Social and Economic Factors								
Need for foreign capital		X						
Lack of financial resources			X					
Cost of treatment/disposal	X	X				X	X	X
Globalization	X	X	X					
EU open borders	X						X	X
World economy / environment linkage			X					
Political Factors								
Politics				X				
Governance			X		X			
Lower regulatory requirements	X	X						
Technological Factors								
No treatment available	X	X				X	X	X
Environmental pressures, need for secondary resources							X	

3.8 Collective Action Framework for the Transboundary Movement of Wastes

Environmental issues are complex and interdisciplinary in nature. The issue of the transboundary movement of hazardous waste can be examined at various levels, including at the

- international level, where all ratifiers to the Basel Convention work together to achieve compliance on a global scale;
- national or intragovernmental level, where decision making within a national government determines the level of compliance;
- firm level, where the generators of the hazardous waste play a role in providing the business arrangements for the disposal of hazardous waste in other countries; and the
- practitioner level, where individual government officials responsible for managing transboundary movements of hazardous waste make decisions on Basel Convention compliance issues.

This research focuses on the national or intragovernmental relations, those actions that occur within a country to bring about decision making at the national level. This research also examines the issue qualitatively at the practitioner level by analyzing the perspectives of government officials responsible for the hazardous waste shipments.

The interactions among the stakeholders at the intranational and practitioner levels will be examined through the lens of collective action. Collective action is pursuit of a goal or set of goals by more than one person. There is interdependency among participants of a collective action, where the efforts of one individual will affect the actions of another. Cooperation "occurs when actors adjust their behavior to the actual or anticipated preferences of others, through a process of policy coordination" (Keohane, 2005, p.51). Each cooperating country or individual is driven toward achieving a specific goal and strives to gain something as a result of its policy adjustments (Ostrom, 2004).

3.8.1 Intragovernmental Level Considerations

3.8.1.1 Domestic Politics

According to Milner (1997), relations between countries and their mutual cooperation toward solving a global international issue, in this case the transboundary shipment of hazardous waste, can be explained by both domestic politics and international relations theory, with both being strongly intertwined. Milner (1997) further suggests the form of international cooperation chosen depends on the specific domestic politics of the individual countries. Internal forces between various national actors and differences among countries in its domestic politics are important to international relations. A country's international position has an influence on its internal politics and economics, and, conversely, the country's domestic politics influences its behavior in the international arena.

Domestic politics is complex because of the number of participating entities or subactors, who may pursue an issue in conflicting ways. Values and beliefs differ significantly within and across societies, and decision makers and general public perceive cost/benefits in subjective rather than objective terms. It is also important to consider that the engaged entities may not be interested in maximum net national welfare, as espoused by the realist theorists, but may be interested in what is good for the majority or a select minority regardless of how this outcome affects the status of their country (Milner, 1997).

Each of the national actors involved in domestic politics, including state leaders, legislatures, agencies, and domestic societal groups, have their own different preferences. It is the extent of the difference in these interests (policy preferences), the way decision-making is shared (institutional structure), and the way information flows within a domestic entity that determine where a nation falls on the anarchy–hierarchy continuum (Milner, 1997). If these groups have differing opinions and all have access to the decision-making process, rule may be by input from the multiple national actors mentioned above.

3.8.1.2 Hazardous Waste as an Externality

The export of hazardous waste, combined with the improper management of that waste, has the potential to cause harm to the environment. As a nonexclusionary global commons, the environment can be shared or degraded freely and the consumer is not

asked to pay the true cost for its use. Common pool resources, which may include commonly owned air, water, and soil, have been freely used by industry. Young (1989) refers to the degradation that occurs to ecosystems when there is competition to exploit these ecosystems for waste disposal. If the use of these resources is free, then there is little or no cost to dumping industrial wastes in these ecosystems and the cost of waste disposal is not considered in the cost of doing business and becomes an economic externality.

Hazardous waste is an externality of industrial production and consumption, in that the impact of the waste is not appropriately compensated for and the price of the industrial product does not account for the social costs of the waste. The industrial facilities using these common resources as dumping grounds do not have to pay the true cost for using these resources, and therefore the resources can suffer continued deterioration (Kneese & Bower, 1979). When these social costs and/or benefits of the production and consumption are not fully considered, market failure may occur. The produced good is underpriced because the negative externality resulting from that good is not taken into account, resulting in a drop in social welfare. The social costs may be the associated health care costs or clean-up costs related to the waste. Therefore, the social cost is the private cost plus the externality. If it is assumed that the industrial producer is interested in maximizing profits, than the producer will only take into account the private costs and benefits and not the social costs and benefits, leading to a greater level of production than is socially optimal.

Theoretically, to account for this externality, each affected party will enter into negotiations with the polluter and be compensated for its exposure to the pollution. Assuming that the neighborhood with the highest negative exposure will present the greatest opposition to the activity and that the neighborhood with the lowest exposure will pose the lowest opposition, then a facility will locate in areas with lowest exposure. This assumption does not take into consideration the economic, political, and educational factors that may inhibit the sustaining of a successful collective action, which may be the case for marginalized populations.

Grossman and Krueger (1995) determined that the strongest link between income and pollution is from citizen demand that calls for strictly enforced environmental regulations. This link between increased income and environmental quality is explained by three factors, including scale (less industrial production equates to less pollution), composition (less polluting industries equates to less pollution), and technology (more advanced technology equates to less pollution). In low-income countries, the literacy rate, political rights, and civil liberties have strong effects on environmental quality (Torras and Boyce, 1998).

Also, the assumption that the most affected communities will present the most effective collective action does not account for the influence of NGOs in supporting and driving the collective action process. NGOs and political interest groups push for government

policies that will correct market failures and mitigate the effect of this economic externality. Parties impacted by the hazardous waste may form opposition groups to this negative externality. The difference in the level of reaction to the externality may depend on the level of political participation. In reality, in areas where there is a larger number of affected parties, these negotiations will have to occur through some form of collective action.

3.8.1.3 Collective Action and the Environment

Because this research quantitatively examines the factors within each country that influence the decision to conform to the Basel Convention requirements, it was necessary to examine internal variations within nations relating to this specific issue, as countries are driven by the internal consequences of cooperative actions. There are 175 parties to the Basel Convention, all having signified their intent to implement its provisions. Each country has internal forces working within it that aid or hinder the process of making collective decisions. The countries do not necessarily coordinate with other countries when implementing the Basel Convention, as this process is conducted internally within the national government.

The theory of collective action is an appropriate way to examine the issue of hazardous waste exports, as the issue encompasses a global environment problem in which nations

have to collectively agree to solve. The environment is a complex system that requires issues to be dealt with through collective action, attributable to the difficulty in solving these issues at the individual level (Johnston, 1996). Collective action can be a force in addressing existing problems and preventing future problems from developing.

When entities within a country interact together to solve a global environmental problem, it is a collective good that is being sought, where everyone benefits from the outcome, whether or not they contributed to the collective action. These entities agree to participate in the collective action in order to reach a mutually agreed upon, socially rational outcome (Sandler, 1992). Although collective action theory has historically dealt with individual choice, it is also acceptable to use it to explain group choice and interaction (Oliver, 1993). Application of this theory can apply to a problem affecting a national collective as well as a regional community or local collective (Ostrom, 1990).

3.8.2 Collective Action at the Individual Level

To understand how these collective action mechanisms can be scaled up to relate to national-level decision-making, it is useful to understand what motivates individuals to participate in a collective action. The early literature, discussed below, on collective action focuses on the behavioral aspects of collective action at the individual level and the motivations behind individual actions.

Theories of collective action emphasize how group behavior can, in some sense, be linked to social institutions. Numerous collective action theorists make their case for studying these actions through different lenses. Three common ways to look at collective action are Mancur Olson's *Logic of Collective Action* (1965), Garrett Hardin's "Tragedy of the Commons" (1968), and the Prisoner's Dilemma Game (Dawes, 1975). All three lead to the conclusion that an individual will act in his/her own self-interest and not contribute to a common benefit (Ostrom, 1990, 2004, 2005).

Olson (1965) sees collective action from an economic standpoint, functioning as a result of the individuals seeking the provision of private goods, available only to those who have joined their collective group. The same individuals will not seek the provision of public goods, as they are available to all and none can be excluded from partaking of the benefit from the public good. Olson states, "Only a separate and selective incentive will stimulate a rational individual in a latent group to act in a group-oriented way" (p. 51). These noncooperative actions lead to overexploitation of common pool resources. This embodies Olson's theory of collective action, which states that individuals will act collectively when it is in their best interests to do so to provide private goods but not public goods, such as the environment. This view leads to the conclusion that the only way to effectively govern a common-pool resource is through centralized government control or through privatization.

Hardin (1968) continues this concept in his "Tragedy of the Commons", where users of common resources strive to maximize their individual benefit while degrading the resource for all. Hardin's essay deals with population growth and the increased demand that these unchecked population increases have on natural resources. Hardin (1968) states, "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a common brings ruin to all" (p. 1244).

The Prisoner's Dilemma view of collective action shows how mutual cooperation would be in everyone's self-interest, but it needs to be enforced in order to ensure compliance. The Prisoner's Dilemma is a two-person game, where enforced collective action leads to the optimum outcome. After studying examples of this form of collective action, Young (1989) reports, "with alarming frequency, those forced to make choices in situations resembling the prisoner's dilemma experience severe difficulties in achieving the level of cooperation needed to avoid mutual losses" (p. 2).

When examining the export of hazardous waste in the context of the Prisoner's Dilemma, the individual is replaced with the decision-making country, and the issue is whether or not the country will export hazardous waste (Table 8). The country is the focus of this research, as it is the entity that controls whether or not a hazardous waste shipment can occur. The outcome matrix in Table 8 can be constructed if the following assumptions are met:

- out-of-country waste treatment/disposal is less costly than in-country treatment/ disposal and does not provide a higher level of environmentally sound management;
- social welfare is increased by in-country waste treatment/disposal.
- in-country waste management would require an investment in technology development; and
- there is information asymmetry in that the countries do not know how the other will act.

Table 8: Two-country Prisoner's Dilemma Matrix related to the decision to export hazardous waste

		Country B	
		Export waste	**Not export waste**
Country A	**Export waste**	Both countries are not in compliance with Basel Convention; minimal social welfare	Country A is not in compliance; Country B is in compliance with the Basel Convention
	Not export waste	Country A is in compliance; Country B is not in compliance with the Basel Convention	Both countries are in compliance with the Basel Convention: optimal social welfare

In the Olson, Hardin, and Prisoner's Dilemma schools of thought on collective action, there is the possibility of "free riding". Exporters of waste may be free riders, enjoying the global protection of the environmental commons, while not contributing to it. The incentive to free ride at the global commons level is high, as there is no overarching authority to sanction noncompliers. Ostrom (1990) shows that free riding may not be as much of a problem in collective actions that do not have a centralized authority, and in some circumstances it may be more efficient to remain decentralized. Cooperation is also difficult to obtain when there is a lack of reciprocity among the parties involved.

There is an alternative to these three views of collective action. Ostrom, the 2009 recipient of the Nobel Prize for Economics for her work in collective action, examines many examples of these actions at the community level and suggests that there is another way to manage these resources, through the use of self-governing institutions. Ostrom (1990) highlights how humans have created diverse institutional arrangements to manage natural resources for thousands of years that have led to sustainable use of the resource and prevention of ecosystem collapse.

3.8.3 Principles for Successful Collective Actions

Without rules or social conventions, rational actors can make choices that fail to achieve optimal outcomes for all involved, creating collective action problems. Some researchers

have stated that the more participants, the greater the probability for less than optimal outcomes (Olson, 1965; Young, 1989). This may have ramifications for the international hazardous waste trade issue, as effective implementation of the provisions of the Basel Convention can be seen as a coordination problem, where success requires interdependent decision-making in order to achieve joint gains. In fact, international institutions such as regimes are developed to address collective action problems, where intercountry cooperation has been difficult to achieve, with these regimes functioning as social institutions that set out the rules for members of the international society (Young, 1989).

In order to understand why some collective actions are successful in cooperating to solve a common problem and why some fail, Ostrom (1990) developed a list of some common principles that long-term, sustainable, common-pool, resource-management institutions exhibit. In analyzing examples of common-pool resource management of varying scales, Ostrom noticed that these institutions tend to evolve over time and that the rules may change in response to changing conditions, but the principles appear to be consistent. The institutions studied were relatively small, community-level scale, and the appropriators, or users, were very dependent on the common-pool resources. Ostrom's principles for successful management of common pool resources include

- clearly defined boundaries for both the common pool resource and those allowed to withdraw from it (entitlements);
- individual's duty to maintain the resource is in proportion to their benefit;

- collective choice agreements: those that need to abide by the rules can participate in revising the rules (democratic decision making);
- monitoring and sanctioning: monitor conditions of resource and behavior, with monitor being accountable to users;
- graduated sanctions: appropriators sanctioning other appropriators;
- conflict-resolution mechanisms;
- recognition by outside authorities of the right of the users to self-organize; and
- multiple layers of nested enterprises for larger institutions.

Ostrom does not want her design principles to be seen as absolute requirements, but rather as "general advice" (Ostrom, 1990; Stern, Dietz, & Ostrom, 2002; Dietz, Ostrom, & Stern, 2003). If these principles are applicable to large-scale, global common-resource issues, like those addressed by the Basel Convention, then the level of democracy and the political structure, as well as the incorporation of the public opinion into the decision-making process, will aid in the prediction of whether a country will comply with this agreement. Independent variables, selected to represent these factors, are analyzed in this research and are discussed in Chapter 4.

Buck (1998) explores Ostrom's principles and states that, when considering global commons, clearly defined boundaries, operational rules congruent with local conditions, monitoring, graduated sanctions, and nested enterprises are most important. The linkages between Ostrom's principles and the challenges facing management of commons are

further illustrated by Stern, Dietz, and Ostrom (2002) and refined by Dietz, Ostrom, and Stern (2003). These principles have been investigated for close to twenty years, through the analysis of collective action case studies, and with minor modification can still help achieve successful and sustainable common-resource governance.

3.8.4 Scalability to National and International Levels

Scale is very important to account for when considering common-pool resources. Most of the collective action literature addresses decision-making at the individual or community level (Hardin, 1968; Olson, 1965; Ostrom, 1990). The challenges of management of the environment as a commons are the same as those that challenge a community-level common-pool resource. A few authors have begun to look at how collective action processes can be scaled up to the global level (Stern et al., 2002; Dietz et al., 2003).

McGinnis and Ostrom (1992) describe the interconnectivity of institutions and regimes succinctly when they state "no global regime can remain robust if it neglects to take account of local circumstances or the conflicting interests of smaller scale collective action organizations" (p. 63). Scaling up from the individual and community level to the national government level involves the inclusion of many more participants, including governmental entities, NGOs, firms, and multinational corporations into the decision-

making process, which may make it difficult to reach consensus. In the case of the Basel Convention, which has no regulatory or enforcement authorities, each nation is required to implement the provisions of the Convention through its own national structure. Therefore the characteristics of each nation will determine how and to what extent it will conduct this implementation. Each country may follow a different path to implementation, and the unique characteristics of each country may help or hinder the success of this national effort. Therefore the social, economic, and political character of the country should help predict the national compliance with the Basel Convention.

There are differences between looking at resources at the local level and at the international level. The most obvious is the size of the resource under consideration. At the global scale, it is more difficult to monitor compliance because of the greater extent of the resource. The users of the resource are usually greater on the global scale and may be more heterogeneous. Research by Olson (1965) has shown that, the more users there are, the less cooperation can be achieved. Ostrom (1990) and Oliver and Maxwell (1985) state otherwise and conclude that more users do not equate to less successful collective actions although it may lead to more costly actions.

Both the characteristics of the national governments and availability of nonstate groups, such as citizens groups and NGOs, to government policymaking processes need to be considered. Due to nesting of levels of institutions and heterogeneity of constituents, there will most likely be more than one policy option to emerge to enhance compliance,

which in this research would be reduction in transboundary shipments. It is unrealistic to assume that one set of conditions will allow all countries studied to reach the same end point. There are activities and conditions that can derail a collective action. In Hardin's "Tragedy of the Commons" (1968), the overuse of a resource by a few can affect the condition and availability of that resource for many. Many times the impacts of the noncompliers affect other jurisdictions and future generations. There may also be a lack of reciprocity where initial users of a resource have no incentive to make sure the resource is available for subsequent users.

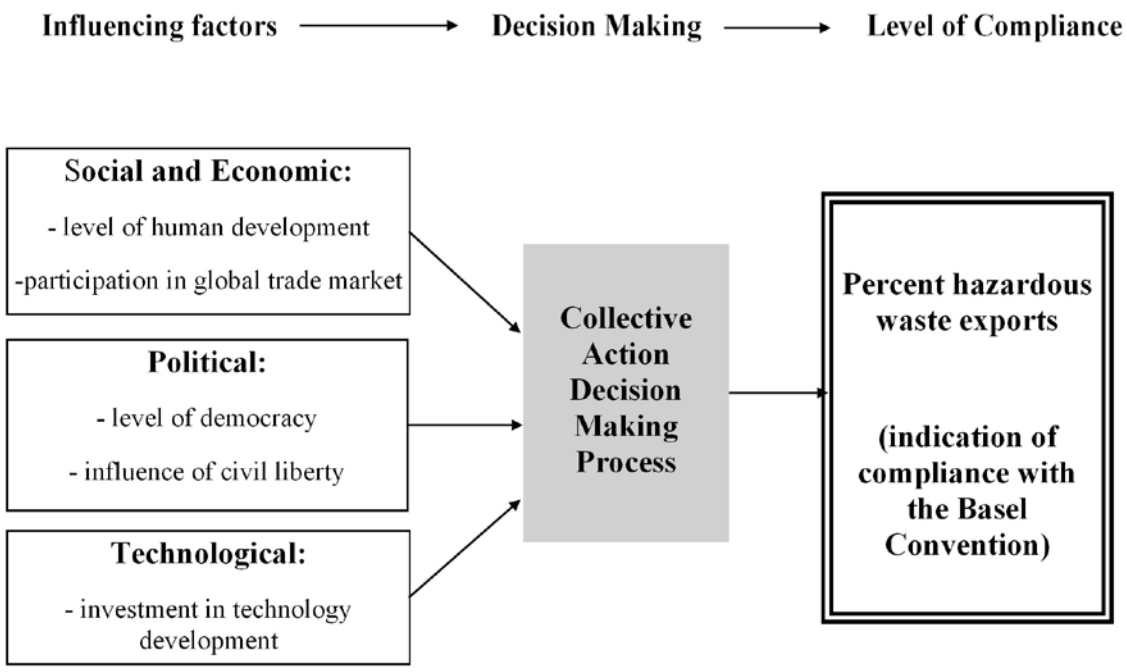

Figure 3: Relationships among predictive variables leading to compliance with the Basel Convention, as measured by the percentage of hazardous waste generated that is exported

Chapter 4: Research Question and Hypotheses

In order to understand what is driving the export of hazardous waste, the issue needs to be examined from a number of perspectives. On the basis of the factors identified as potential predictors of hazardous waste export in the literature (discussed in Chapter 3) and a review of the collective action literature and its application at the national level, it is clear that social, economic, and political factors are at work. The importance of technology development is also discussed in the scholarly literature on the hazardous waste issue (European Environment Agency, 2009; Fan, Chang, Ni, & Lee, 2005; Hsing, Wang, Chiang, & Fang, 2004; Krueger, 1998; OECD, 1985; Singh & Lakhan, 1989), and it is included in this research as a predictive variable.

4.1 Research Question

"Can the variances in compliance records of countries that have ratified the Basel Convention, as determined by the extent of transboundary shipments of hazardous wastes, be explained in terms of social, economic, political, and technological factors?"

A review of the hazardous waste literature indicates that certain societal, economic, political, and technological factors drive the hazardous waste trade (Table 7). Assuming

that each country facilitates its governmental decision-making process through collective action and the decision to allow transboundary shipments of hazardous waste is made by the government, then the social, economic, political, and technological forces acting on the government need to be examined. In order to examine the research question, it is important to understand the attributes through which this issue is filtered, the governmental structure and the political dynamics of the processes that collectively shape and execute environmental policies.

The Basel Convention requires the process of prior informed consent, embodied in the Basel Convention, designating that the government is the entity responsible for granting permission to export and import, not the waste-generating, treatment or shipping companies, although these entities are responsible for identifying that an appropriate facility is available to receive the shipment (UNEP, 2009a). Before any transboundary hazardous waste shipment can proceed, the exporting country must have the permission of the importing country and any countries the waste will transit through. It is assumed that no one person makes decisions for a government, but the policy is ultimately developed through collective action, reflecting the political and social forces acting on the government.

4.1.1 Dependent Variable

Dependent Variable: Level of compliance with the Basel Convention provision to minimize transboundary shipments of hazardous waste as measured by the percentage of total hazardous waste generated that is legally exported by country.

Source of Data: Basel Convention National Reporting Database

http://www.basel.int/natreporting/index.html

This is the most comprehensive and current database for Basel Convention-specific information on hazardous waste production and export values.

There is no direct measurement of compliance to the Basel Convention; it is a nonobservable entity that requires a proxy variable. Because one of the three goals of the Basel Convention is to reduce the number of transboundary shipments of hazardous waste, the percentage of waste generated that is exported is considered a measure of compliance. In order to quantify this variable, a cross-sectional view, by country, of the percentage of hazardous waste generated that is exported was determined for 2006, which is the most recent, available published dataset. It would be interesting to examine trends in hazardous waste export over time to determine whether countries were working toward reducing their exports, but, because of the incompleteness of the Basel Convention National Reporting Database, it is only possible to generate time series export data for a

limited number of countries. Therefore, the cross-sectional approach was selected for this research.

4.2 Hypotheses

Five hypotheses were generated from insight obtained through a review of the literature relating to the transboundary shipments of hazardous waste and collective action theory. This research aggregates data at the macro level to examine predictive factors, using countries as the analysis unit. All countries that have ratified the Basel Convention are included in the quantitative analysis, if complete hazardous waste generation and export data for 2005 or 2006 were submitted. Fifty-five countries are included in the research dataset (Table 9).

Table 9: Countries included in the research dataset

Countries included in the research dataset				
Brunei Darussalam	Bosnia & Herzegovina	United Kingdom	Republic of Korea	Republic of Moldova
Andorra	Chile	France	Malta	Romania
Argentina	China	Germany	Mexico	Singapore
Australia	Costa Rica	Greece	Morocco	Slovakia
Austria	Croatia	Hungary	Mozambique	Slovenia
Azerbaijan	Cuba	Ireland	Netherlands	Spain
Bahrain	Cyprus	Israel	Norway	Sri Lanka
Belarus	Czech Republic	Italy	Poland	Sweden
Belgium	Denmark	Kiribati	Portugal	Ukraine
Bulgaria	Egypt	Latvia	Qatar	Finland
Algeria	Estonia	Luxembourg	Malaysia	Zambia

A data source for each variable was chosen on the basis of its applicability to the scope of this study and the representiveness to each characteristic being examined. Each of the data sources chosen is global in scope, consistent in data-collection methods, and from an internationally reputable source, such as various offices of the United Nations (UN).

4.2.1 Social and Economic Independent Variables

To examine the influence of social and economic factors on compliance with the provisions of the Basel Convention, five independent variables were selected to examine the two hypotheses (H1 and H2) presented below, including:

- level of human development (H1),
- international trade (H2), including
    - trade extent: total value of exports/gross domestic product (GDP);
    - trade structure: number of UN Harmonized System commodity categories exported; and
    - trade openness: two indices representing the freedom to trade internationally.

Hypothesis (H1): As a country's Human Development Index (HDI) increases, the percentage of its hazardous waste that is exported decreases.

H1 Independent Variable: *Level of human development* to include social as well as economic factors

Source of data: UN Development Program (UNDP) HDI
http://hdr.undp.org/en/media/HDI_2008_EN_Tables.pdf

In examining the level of human development, researchers have stated that, if people can develop to their fullest potential through having their basic human needs met, having access to education, and having enough money to survive, then environmental issues, such as management of toxic wastes, become more important (Grossman & Krueger, 1995; Torras & Boyce, 1998; Dasgupta, LaPlante, Wang, & Wheeler, 2002). Torras and Boyce (1998) discuss this conclusion when they test the hypothesis of Grossman and Krueger (1995) that increasing per capita income is the main explanation for increasing environmental quality, the idea behind the environmental Kuznets Curve. This relationship is named after the original Kuznets Curve, which shows the relationship between income per capita to economic inequality as a country develops. Torras and Boyce (1998) quantitatively indicate that level of literacy and an aggregate of political rights and civil liberties are important factors to consider in order to have a more complete explanation for the range of environmental degradation found worldwide. The

GDP of a country is sometimes used to evaluate a country's level of development, representing the economic component. The HDI is an alternative way of measuring the level of a country's development, and it incorporates social and economic factors to examine development in terms of human well-being. The HDI is a global measure of a country's achievement in three areas including:

- a long and healthy life, as measured by life expectancy at birth;
- access to knowledge, as measured by adult literacy and combined primary, secondary, and tertiary education gross enrollment ratios; and
- a decent standard of living, as measured by GDP per capita (UNDP, 2007).

An index is calculated for each of these three measures, and the HDI is the simple average of these three indexes (UNDP, 2007).

Higher levels of human development can be achieved through the creation of an environment where people have more choices on how to live their lives. Amartyna Sen, 1998 Nobel Prize winner for Economics, refers to the HDI as reflecting the richness of lives vs. the richness of the economy alone (UNDP, 2009). The HDI is published on an annual basis as an independent report commissioned by the UNDP. This research predicts an inverse relationship where, as the HDI increases, the amount of hazardous waste exports will decrease.

Hypothesis (H2): As a country's level of international trade increases, the percentage of its hazardous waste that is exported increases.

H2 Independent Variables: three trade-related independent variables are analyzed, including trade extent (per GDP), trade structure, and trade openness.

Sources of data: Two data sources and three measures of participation in global trade are used in this analysis. The results are compared to determine whether the examination of various aspects of international trade, as represented by the three variables, affects the statistical results.

International Trade Statistics, available from International Trade Centre, UN Conference on Trade and Development/World Trade Organization
http://www.intracen.org/tradstat/sitc3-3d/indexre.htm

If hazardous waste is considered a commodity of value, a country's trade extent, trade structure, and trade openness should predict the country's propensity to participate in the hazardous waste export trade.

Trade extent: Neumayer (2002a) posits that, the more a country is a net exporter of goods, the more incentive there will be to participate in multilateral cooperation, which may include environmental cooperation. According to Newmayer, the more open a

country is to trade, the more likely it is to cooperate in other policy areas. He states that the incentive will be particularly strong in countries whose economic activities may have a negative transboundary environmental effect, as the exporting country will wish to dispel the idea that it is exploiting its good economic fortune to the detriment of others. Neumayer (2002a) further states that participation in multilateral agreements, including environmental ones, signals that a country wants to participate in global trade, and environmental concessions may be necessary in order to become involved in other areas of global cooperation. The opposite could also be true in that participation in multilateral environmental agreements can cause a country to incur significant cost and may restrict trade, both of which could apply to the Basel Convention. Therefore, a country may decide not to participate because it does not see a favorable cost vs. benefit. As a country increases its participation in the global trade market, it will develop trade relationships and an international trade infrastructure, which will allow increased trade in all commodities, including hazardous waste. Globalized trade is mentioned by numerous authoers as a factor leading to trade in hazardous waste (Clapp, 1994, 2001; OECD, 1985). This research predicts a positive relationship between a country's export volume and the amount of hazardous waste exported.

Trade extent is a function of the value of total merchandise exports, in relation to the GDP, both measured in current U.S. dollars for 2006. In order to determine the magnitude to which a country participates in globalized trade, it is necessary to determine its level of export of all product designations. The International Trade Statistics,

compiled by the UN Conference on Trade and Development and World Trade Organization (WTO) provides comprehensive statistics on import and export of 1,250 product groups of the Harmonized System for individual countries from 2001–2008. The Harmonized System provides tariff nomenclature that is used by over 170 nations and is the basis for generating international trade statistics. In order to determine the magnitude to which a country participates in globalized trade, it is necessary to determine its amount of exports in all product designations. The trade export data may come from COMTRADE (a UN Statistics Division database covering about 90% of world trade), Eurostat (European Union statistical office), or various national or regional entities, with the source varying by country.

Trade structure: The broadness of the export structure, as determined by the number of categories of trade exports, may also influence the participation of a country in international agreements. Roberts, Parks, and Vasquez (2004) state that, when a country relies on a few categories of exports, such as a developing country that may only export a limited number of raw or marginally processed materials, the export may be controlled by those who may not wish to see environmental protections put into place because they may restrict the availability of these resources. This narrowness of trade may leave the country vulnerable to changes in the market, which may prevent the economic growth that will allow the country to participate in international treaties. This research predicts a positive relationship where greater participation in globalized trade will lead to greater export of hazardous waste, as the waste would simply be another exportable commodity.

To determine the broadness of the trade structure, which can also be referred to as level of export diversity, the total number of two-digit UN Harmonized System categories, exported by country was calculated for each country. When categorizing exports, there are a total of 97 two-digit categories available.

Trade openness: This trade concept encompasses information on the barriers to trade, such as trade taxes, currency exchange rates, size of the actual vs. the expected trade sector, and the restrictions on citizens to trade internationally. According to Neumayer (2002a), countries that have fewer restrictions on international trade will be more likely to cooperate in international agreements. Participation in global markets, both as exporters as well as importers, will allow the influx of new ideas and knowledge, which could increase concern for global environmental issues. However the converse can also be true, where a country that trades freely in the international markets may be more prone to export its hazardous waste as it has the trade infrastructure and networks to do so. Clapp (2001) refers to fluidity of trade in the global marketplace as one factor leading to the export of hazardous waste. This research predicts a positive relationship between trade openness and the export of hazardous waste.

Studies in the literature use two indices to calculate the freedom of a country to trade internationally. Different methodologies are used to determine each of the indices, so both were included in this research for the sake of completeness.

- Economic Freedom of the World (EFW) Report, Area 4:

Freedom to Trade Internationally

http://www.freetheworld.com/release.html

EFW index, calculated by the Fraser Institute (2009), an independent research and educational organization based in Canada, reflects how a nation's institutions and policies are consistent with economic freedom on the basis of "personal choice, voluntary exchange coordinated by markets, freedom to enter and compete in markets and protection of persons and their property from aggression from others" (p. 3). This concept encompasses information on the barriers to trade, such as trade taxes, currency exchange rates, size of the actual vs. the expected trade sector, and the restrictions on trade by citizens.

- The Index of Economic Freedom, including data on trade freedom, is produced by the Heritage Foundation, a Washington, D.C. think tank, and the Wall Street Journal. This index contains information on two factors, including trade-weighted average tariff rates and nontariff barriers.

  http://www.heritage.org/Index/Explore.aspx

4.2.2 Political Independent Variables

To examine the influence of democracy on compliance with the provisions of the Basel Convention, two variables were selected for analysis including the following:

- level of democracy (H3) and
- tolerance of the government to the involvement of civil society; as measured by the number of nongovernmental organizations (NGOs) per capita (H4).

Hypothesis (H3): As a country's level of democracy increases, the percentage of its hazardous waste that is exported decreases.

H3 Independent Variable: level of democracy by country

Source of data: Democracy Index prepared by The Economist Intelligence Unit (EIU) http://graphics.eiu.com/PDF/Democracy%20Index%202008.pdf

Governments in democratic political systems are more responsive to societal demands, including calls for environmentally protective policies. Democracy allows the freedom necessary for civil society to participate in national policy discussions. In collective actions, if maintaining sovereignty is a problem at the international level, then democracy, or lack of it, may pose a problem at the national level (Olson, 1993). A number of studies have shown that democracy has a positive effect on the environment. Democracies allow citizens to be better informed about environmental issues, better able to express their environmental concerns, and better able to organize to address environmental issues, which lead to pressure being put on the government through the power of the vote (Payne, 1995). Congleton (1992) describes how authoritarian governments are less responsive to citizens' environmental demands. Neumayer (2002b)

presents evidence that an increase in democracy worldwide will bring about an increase in environmental commitment. Desai (1998), however, feels that the correlation of democracy and environmental protection begins to fall apart in developed, industrial countries, as evidenced by the amount of greenhouse gasses and hazardous waste these countries produce. This research predicts an inverse relationship between level of democracy and the export of hazardous waste.

There are numerous ways to describe democracy. The EIU Democracy Index was chosen because it is based on five different categories of data including the electoral process and pluralism, civil liberties, the functioning of the government, political participation, and political culture. Evaluation of this information results in the classification of governments into four regimes, ranging from authoritarian to full democracy. The Index of Freedom in the World produced by the Freedom House is sometimes used in the literature as a proxy for level of democracy (Barrett & Grady, 2000; Neumayer, 2002b). The EIU's index is more comprehensive in scope than the Freedom House freedom index, which measures civil liberties and political rights.

Hypothesis (H4): As a country's level of tolerance to civil society increases, the percentage of its hazardous waste that is exported decreases.

H4 Independent Variable: Number of NGOs per capita

Source of data: World Association of Non-Governmental Organizations (WANGO) http://www.wango.org/resources.aspx?section=ngodir

It is hypothesized that a government's actions are constrained by the society it governs. The role of the citizen in influencing his or her government's environmental policies and the role of collective action as a mechanism for influencing national policy need to be examined. It is important to account for the influence of civil society, which is the interaction that occurs between the individual and the state. NGOs form from this civil society to address issues of concern to members of civil society, and NGOs can be strong social and political actors for change (Wapner, 2000). Accepting the assumption that the development of environmental policy is partly a function of societal and political demand for environmental quality and governmental policies to protect the environment, the strength of these demands and the government's tolerance of these demands can be inferred by the number of NGOs operating in the country. The number of NGOs proportional to the population of the country is used as a proxy for a government's tolerance to citizen participation. Although Wapner (2000) acknowledges that states are the main actors in global governance matters, and civil society is not more important than the state, he states that the political nature of the NGOs can influence behavior and direct involvement in the policy-making process. Roberts et al. (2004) confirm this when they equate domestic civil society mobilization with the total number of NGOs operating in the country. Through her analyses of collective actions, Ostrom (1990) suggests that

community groups and NGOs may be more effective in protecting environmental resources than government agencies. This research predicts an inverse relationship between the government's tolerance of civil society and the export of hazardous waste.

The challenge in quantifying this variable lies in obtaining the most comprehensive listing of NGOs operating in each country. WANGO is an international entity whose goal is to unite NGOs worldwide and provide a mechanism for these organizations to connect and partner on issues. Currently there are approximately 49,500 NGOs listed by country and interest area in the WANGO directory.

The term "environment" can take on many meanings and encompass different areas of interest in different organizations, and it may not be possible to determine from the name of the NGO whether its focus is on the environment. It is assumed for this research that environmental concern is reflected in the total issue concern in each country. Because it is the goal of this research to examine the government's tolerance to all civil society, all NGOs, not just those labeled as "environmental", will be considered. Also, the geographic level at which NGOs operate, for example, internationally, regionally, nationally or local, is not a concern for this research. In order to take into account the wide range in population size of the study countries, this variable is represented on a per capita basis to allow the cross–country comparison of governmental tolerance.

Another method of calculating this variable is through the UN Economic and Social Council (UN ECOSOC), which enables NGOs to participate in activities throughout the UN structure. NGOs apply for consultative status with the UN ECOSOC. As of January 2011, there are 3,336 NGOs that have been granted consultative status. This is a smaller dataset than that maintained by WANGO and may not include those NGOs that prefer to operate on the national level or local level and do not choose to seek consultative status with the UN. Because the focus of this research is on domestic collective action, the WANGO database was selected as the data source for this research.

4.2.3 Technological Independent Variable

To examine the influence of technology development support on compliance with the provisions of the Basel Convention, one variable was selected for analysis, gross domestic expenditure on research and development (GERD), as percentage of GDP.

Hypothesis (H5): As a country's level of technology development support increases, the percentage of its hazardous waste that is exported decreases.

H5 Independent Variable: Amount of funding in support of research and development (R&D) in relation to total GDP

Source of data: UNESCO Statistics on GERD, in particular R&D expenditure as percentage of GDP

http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656

A review of the literature relating to the transboundary shipment of hazardous waste highlights lack of in-country treatment and disposal options as an explanatory factor for the export (European Environment Agency, 2009; Fan et al., 2005; Hsing et al., 2004; Krueger, 1998; OECD, 1985; Singh & Lakhan, 1989). In order to examine the connection of available technology to the treatment of hazardous waste in a country, the intensity of funding allocated to R&D in relation to GDP, is included in the analysis.

As environmental regulations become stronger, the requirements for treatment and disposal increase, and costs to the waste generator increase. For example, stricter regulations may require more expensive incineration where land disposal has been permitted in the past. This increase in cost has been cited as one of the reasons generators and waste handlers look to countries with less strict or nonexistent environmental regulations to dispose of their waste (Krueger, 1998; OECD, 1985; Singh & Lakhan, 1989). If these hazardous waste shipments are sent without the permission of the importing country, the shipment is considered illegal.

In order to provide the appropriate in-country treatment, the development of advanced waste treatment and disposal technologies is necessary, which requires an expenditure of

funds to support R&D in the waste management area. R&D support may indicate the level of innovation directed toward development of new processes and products that exist in a country, and R&D support can be used indirectly as a measure a country's investment in the attainment of knowledge (OECD, 2009). R&D is a combination of the actual expenditures and the personnel involved in R&D. A country that devotes a higher percentages of its GDP to R&D may be in a better position to treat or dispose of its hazardous waste close to the point of generation as required by the Basel Convention and within its national borders. Because comprehensive cross-national data on expenditures for the development of specific waste management technologies are not available, the percentage of the GDP spent on R&D, also known as R&D intensity, is used as a proxy variable.

In order to allow governments to refer to international benchmarks in R&D spending, the UNESCO Institute for Statistics works with governments and organizations to produce global information on science and technology, as well as R&D expenditures (UNESCO, 2010). A common statistic to describe a country's commitment to support R&D activities is R&D intensity, which is national GERD expressed in terms of percent of GDP. Because R&D varies with GDP over the business cycle, a weakening economy will have an associated drop in R&D expenditures. Therefore, values for R&D expenditures/GDP are a more stable indicator than R&D expenditures alone. R&D intensity is used as the proxy independent variable for technology development support.

This research predicts an inverse relationship between support for technology development and export of hazardous waste.

Other statistics to describe support of technology development that were considered as potential independent variables included number of R&D personnel, or more specifically researchers, number of scientific patents, and number of scientific articles published. The data available for these statistics was determined to be less complete than the GERD/GDP statistic; therefore these additional technology statistics were not used in this analysis.

Another potential independent variable, the number of hazardous waste disposal facilities per country, was considered. Countries are required to submit this information as part of their annual national reporting to the Basel Convention. However, this dataset is inconsistent with many countries not reporting, reporting only in general terms that do not distinguish between hazardous and nonhazardous waste disposal sites, or stating that the number of existing facilities are too numerous to report. Inclusion of this variable increases the number of cases (countries) with missing data by ten, without providing useful, comparable data; therefore it was not considered in this research.

Figure 4 presents the conceptual causal model with predicted coefficient directions. Table 10 summarizes the research question and associated hypotheses and describes how the data for each variable were obtained.

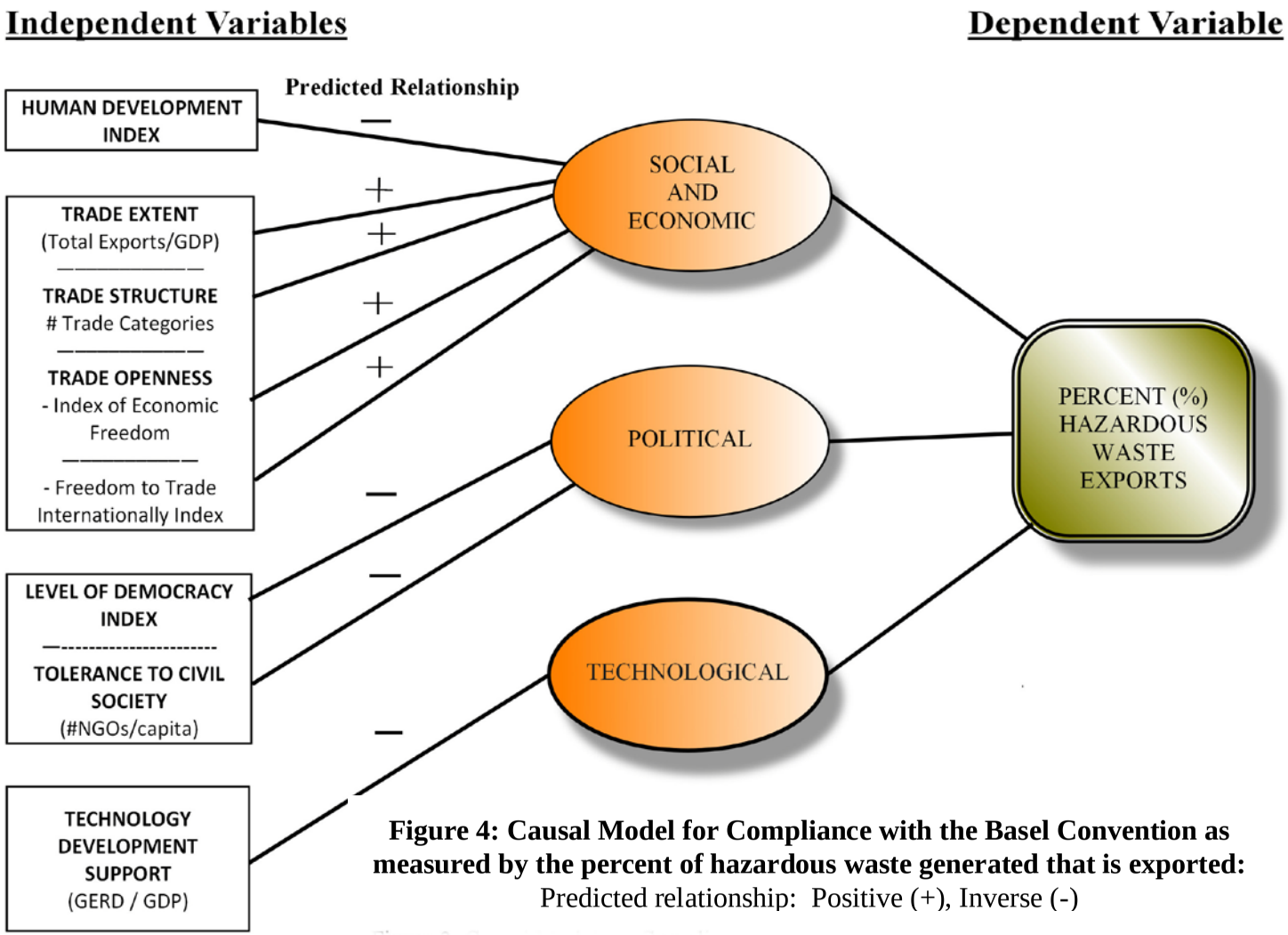

Figure 4: Causal Model for Compliance with the Basel Convention as measured by the percent of hazardous waste generated that is exported:
Predicted relationship: Positive (+), Inverse (-)

Table 10: Summary of research question and hypotheses, with dependent and independent variable descriptions and data sources

Research Question: "Can the variances in compliance records of countries that have ratified the Basel Convention, as determined by the extent of transboundary shipments of hazardous wastes, be explained in terms of social, economic, political, and technological factors?"		
Dependent Variables: Level of compliance with the Basel Convention provision to reduce transboundary shipments of hazardous waste as measured by the percentage of total hazardous waste generated that is legally exported by country. Source: Basel Convention National Reporting Database http://www.basel.int/natreporting/cfs.htm		
HYPOTHESES	**INDEPENDENT VARIABLES**	**SOURCE OF DATA**
Social and Economic		
Hypothesis (H1): As a country's Human Development Index (HDI) increases, the percentage of its hazardous waste that is exported decreases.	Level of human development by country to include social as well as economic factors	United Nations (UN) Development Program HDI http://hdr.undp.org/en/media/HDI_2008_EN_Tables.pdf
Hypothesis (H2): As a country's level of international trade increases, the percentage of its hazardous waste that is exported increases.	Trade extent - total value in exports per capita by country Trade structure - total number of International Harmonized System trade categories per country Trade openness - freedom to trade internationally (Fraser Institute)	International Trade Statistics, International Trade Centre UN Conference on Trade and Development/WTO, http://www.intracen.org/tradstat/sitc3-3d/indexre.htm Economic Freedom of the World Report, Area 4: Freedom to Trade Internationally (Fraser Institute) http://www.freetheworld.com/release.html

	Trade openness - freedom to trade internationally (/Heritage Foundation/WSJ)	Heritage Foundation and Wall Street Journal Index of Economic Freedom http://www.heritage.org/Index/Explore.aspx
Political		
Hypothesis (H3): As a country's level of democracy increases, the percentage of its hazardous waste that is exported decreases.	Level of democracy present by country	Democracy Index prepared by The Economist Intelligence Unit http://graphics.eiu.com/PDF/Democracy%20Index%202008.pdf
Hypothesis (H4): As a country's level of tolerance to civil society increases, the percentage of its hazardous waste that is exported decreases.	Total number of nongovernmental organizations (NGOs) by country per capita	World Association of Non-Governmental Organizations http://www.wango.org/resources.aspx?section=ngodir
Technological		
Hypothesis (H5): As a country's level of technology development support increases, the percentage of its hazardous waste that is exported decreases.	Percent of funding in support of research and development in relation to the country's total gross domestic product (GDP)	UNESCO Statistics on Gross Domestic Expenditure on research and development (R&D) (GERD), in particular R&D expenditure as percentage of GDP http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=2656

Chapter 5: Methodology

A review of the literature in Chapter 3 indicates that studies have identified recurring themes, indicated in Table 7, which may be responsible for the export of hazardous waste. The transboundary shipment of hazardous waste is still a major concern to both developed and developing countries, as evidenced by the recent global activities described in Chapter 1.0.

Using mixed methods can be a very useful technique in collective action studies. Larger-*n* studies are needed for the evaluation of generalized relationships, such as the cross-country quantitative analysis conducted during this research. Small-*n* studies are useful for developing a feel for context and specific needs, as in the qualitative survey of the government officials, also conducted during this research. The specificity of the information gathered in the small-*n* studies may be lost because of the scale of the larger-*n* studies, but this information is important because it may provide a view into implementation of broader policy options (Poteete, Janssen, & Ostrom, 2010).

Limited data exist on what factors can predict whether a country will comply with commitments made through the ratification of international treaties and none specifically related to the Basel Convention. This research uses both quantitative and qualitative

methods to examine the transboundary waste-shipment issue from two different perspectives. The larger *n* quantitative cross-national approach yields a look at broader long-term solutions to the issue, whereas the smaller-*n* qualitative approach provides insight into more immediate, short-term needs.

5.1 Description of the Dataset

This research examines the predictive ability of the social, economic, political, and technological variables identified in the literature in the context of the transboundary shipment of hazardous waste. The data for the dependent and independent variables are obtained from publicly available sources maintained by international organizations, with the quality assurance of the data being conducted by the responsible international organization. Some of the international databases are constructed of national-level self-reported data, which may be incomplete for a variety of reasons. For example, there may be insufficient infrastructure to collect and analyze the data; there may be higher priorities for available resources; or the country may choose to submit incomplete or no data at all. This results in incomplete datasets that need to be addressed before any statistical analysis of the data.

5.1.1 Dependent Variable

The dependent variable measures the level of compliance with the Basel Convention provision to reduce transboundary shipments of hazardous waste as determined by the percentage of hazardous waste that is exported.

Only countries that have ratified the Basel Convention are included in the research dataset. As of March 2011, 175 parties have ratified the Convention. Three countries, including Afghanistan, Haiti, and the United States, have signed but not ratified the Convention and are not included in this research.

The most recent quality-assured data available for the dependent variable is from the 2006 Basel Convention National Reporting Questionnaire; therefore this is the dataset used in this research. In order to achieve consistency, all other independent variables use 2006 data, where available.

The dependent variable, "percent of hazardous waste exported", is calculated from information submitted in Part II of the annual national reports submitted to the Secretariat of the Basel Convention. Values for the amount of hazardous waste generated and the amount of hazardous waste exported are required to calculate the dependent variable. Only countries that reported data useable for calculating the dependent variable were used in the study. For 2006, 51 countries reported data allowing calculation of the

dependent variable. The dependent variable data were augmented by the addition of five other countries (Azerbaijan, Bulgaria, Italy, Portugal, and Ukraine) that submitted complete data in 2005. For the countries that reported 2005 data but not 2006 data, values for 2006 were estimated on the basis of the mean of the difference between observed 2006 and 2005 dependent variable data for those countries that reported for both years. The total number of countries included in the dependent variable dataset is 55 (Table 9).

The Basel Convention National Reporting database is the most complete global dataset available for the amount of hazardous waste exported. Other, more selective sources of data on hazardous waste exports are available, such as data for countries in the European Community or the Organization for Economic Cooperation and Development (OECD) countries. The definitions of hazardous waste used by these organizations may differ from the Basel Convention definition and therefore are not directly comparable. The World Customs Organization does not list a specific harmonized classification code for hazardous waste, as various waste products are described by over 30 specific product codes within four different chapter-level codes. To maintain consistency in the calculation of the dependent variable, the national level data reported to the Basel Convention are used in this research.

Initially, the dependent variable was examined as a dichotomous value, for example, *yes* denoting that a country exports waste and *no* denoting that a country does not export

waste. In reviewing the Basel Convention National Reporting Database, the percent of exported waste exported ranges from 0– 100% of the total waste generated. It was determined that, by using this binary classification, a significant amount of data regarding the magnitude of export would be lost. This potential oversimplification of the data is avoided by using the percentage value.

5.2 Missing Values Issues

Missing data is a common problem when dealing with comparative politics, international relations, and social science issues (Acock, 2005; Horton & Kleinman, 2007; Ibrahim, Chen, Litsitz, & Herring, 2005; Little & Rubin, 1990; Raghunathan, 2004). The best option is to have no missing data; however self-reported data at the national level is often incomplete and may result in an incomplete dataset that is unsuitable for some statistical analyses.

As mentioned in Section 5.1, the datasets used for the dependent and independent variables are not complete. The missing data for the independent variables are summarized in Table 11.

Table 11: Missing data for Dependent and Independent Variables
(untransformed values)

	Countries with missing data	Countries missing data (number)	Countries missing data (percent)
Dependent Variable			
Percent of hazardous waste exported		0	0
Independent Variables			
Trade structure		0	0
Civil tolerance		0	0
Human Development Index	Kiribati	1	1.8
Trade extent	Cuba	1	1.8
Trade openness #2: Trade Freedom: Heritage Foundation/ Wall Street Journal	Brunei Darussalam Kiribati Qatar	3	5.5
Level of democracy	Andorra Brunei Darussalam Kiribati	3	5.5
Trade openness #1: Freedom to Trade Internationally: Fraser Institute	Andorra Belarus Brunei Darussalam Cuba Kiribati Qatar	6	10.9
Technology development support	Algeria Andorra Bahrain Brunei Darussalam Chile Costa Rica Kiribati Mexico Mozambique Qatar Zambia	11	20.0

There is no consensus about how much missing data is too much for various analyses. Schafer (1997) states that, if the dataset contains less than 5% missing values, and these values are missing at random, then listwise deletion can be used and missing values analysis is not required. Other estimates range from 10% (Bennett, 2001) to 20% (Peng, Hartwell, Liou, & Ehman, 2007). Rather than a specific value, Schlomer, Bauman, and Card (2010) discuss the retention of statistical power and the pattern of missingness as the important considerations. The amount of bias introduced into the analysis may depend on whether the data are

- missing completely at random (MCAR): missing values are not related to any of the variables and there is no pattern,
- missing at random (MAR): missing data are related to observed variables but not other missing variables, or
- not missing at random (NMAR): missing values may be due to other values of that same variable and there is a pattern to the missing values.

5.2.1 Dependent Variable Missing Data

One of the major areas of noncompliance with the Basel Convention involves the nonreporting of annual hazardous waste information by countries. For 2006, 92 countries submitted national reports as required by Article 13(3) of the Basel Convention; however not all these reports contain data on quantities of hazardous waste generated and

exported, data that are required to calculate the dependent variable. Because of the large amount of missing data in the dependent variable dataset, only countries that have available national reporting information for 2006 were included in the research dataset, amounting to 55 countries, representing 60% of the countries that submitted annual reports for that year. As a result of missing national data, it was not possible to have equal representation along the development spectrum, as many of the nonreporting countries include developing countries, least-developed countries and small-island developing countries as classified by the United Nations in 2007. Table 12 shows the distribution of the countries included in this research by Human Development Index (HDI).

Table 12: Human Development Index (HDI) value for countries included in the research dataset*

Level of Human Development (HDI)	HDI value	Percent of total countries	Number of countries
High	≥ 0.800	81.1	43
Medium	0.500 – 0.799	15.1	8
Low	<0.500	3.8	2
TOTAL		100%	53

*(HDI value for Kiribati is not available for 2006)

Concern over the nonreporting of annual national data prompted the Secretariat of the Basel Convention to implement a study to determine the reasons for the low reporting

rate. Several reasons leading to nonreporting of hazardous waste generation, import and export values, as identified by parties to the Basel Convention, include the following:

- "complexity of the Basel Convention,
- lack of strategies to deal with hazardous waste,
- lack of coordination and fragmentation of roles,
- lack of resources and knowledge in conducting an inventory,
- waste types to be reported,
- export policies, and
- harmonization with World Customs Organization codes" (Basel Convention, 2009; p. 5).

5.2.2 Independent Variables Missing Data

Most statistical-analysis methods assume there are no missing data, with the analysis only being performed on datasets containing complete data. There are numerous statistical methods to address missing data, and the method chosen may affect the bias and efficiency of the statistical analysis (Little & Rubin, 1990).

- Listwise or case deletion removes all cases where data are missing and is commonly seen in the literature as a method for dealing with missing data. Depending on the amount of missing data, this technique can result in the loss of a significant amount of data, potentially resulting in an increase in standard error, a

reduction in the level of significance (reduced statistical power), and bias. If the data are not missing completely at random, the results may be biased because the complete cases may not be representative of the total population, and listwise deletion may result in erroneous results (Acock, 2005). Of the 172 ratifying countries in 2006, 138 countries have data missing in at least one variable, which would result in a dataset of 34 countries and a loss of 80% of the cases, if listwise deletion was used to address the missing values. Much of the data on developing countries are lost if listwise deletion is used.

- Pairwise deletion does not delete the entire case if data are missing. Using all possible pairs of data may produce a covariance matrix that may be impossible to achieve in a single population. Pairwise deletion makes it difficult to calculate the degrees of freedom, as each subsample differs depending on the pairs analyzed. The advantage over listwise deletion is that it uses all available data.
- Mean substitution calculates the mean, which is assumed to be a good estimate for a randomly selected data point in a normal distribution. In order for this estimate to be a good estimation of the missing value, the data must be missing at random, and the amount of missing data should not be large. Incorrect estimates with inconsistent bias may produce a poor guess when these two dataset characteristics are not met.
- Expectation maximization (EM) is a two-step iterative process that creates a new dataset with no missing values. On the basis of the observed relationships among all the variables, EM generates this dataset as well as a degree of random error to

reflect the uncertainty of the imputation. EM uses a maximum-likelihood approach in which the observed data are used to estimate parameters and then missing values. EM tends to underestimate the standard errors and overestimate the level of precision, making the data look like they have more statistical power than they actually do.

- Single imputation can be accomplished using the EM approach, which produces estimates of the missing values. Imputation is the substitution of a plausible value for one that is missing through mean substitution or regression. The complete dataset is then analyzed using standard statistical procedures. The estimated data are analyzed as if they were real data, assuming a level of precision that may not actually exist and assigning more statistical power to the data than actually exist.
- Multiple imputation can estimate standard errors that are unbiased because it pools the parameter estimates to obtain an improved parameter estimate and can incorporate missing data uncertainty. Multiple imputation creates numerous complete datasets, usually in the range of 5–10, estimates the regression model for each of the multiple datasets, and finally combines the estimates and the standard errors of all the solutions. Multiple imputation allows for unbiased standard errors, retaining the benefits of imputation without the drawbacks of the single-imputation method.
- Full-information maximum-likelihood estimation (MLE) uses all available to calculate an estimate of the missing data but does not impute the data. Full-

information MLE is used in structural equation-modeling programs, with or without latent variables.

Multiple imputation is the missing values analysis method selected for this research. The diagnostic statistics that determined multiple imputation to be the most appropriate missing values method are discussed in Section 5.2.3.

5.2.3 Descriptive Statistics for Missing Values Analysis

The choice of the correct procedure for handling missing data depends on the pattern of missingness of the data, which determines whether the pattern of the missing data to the observed data is missing completely at random, missing at random, or not missing at random, as described in Section 5.2.

In order to use listwise deletion, pairwise deletion, mean substitution, or regression estimation appropriately, the assumption that the missing data is not dependent on the variable values in the complete data matrix, or missing completely at random, must be met. If the data are not missing completely at random, the results of the missing values analysis using these methods can give biased results. The EM estimation method may be used if the data are missing at random or not missing at random. Meeting the missing at random assumption means the missing data may be dependent on the observed data

values, but not on the missing values, and is less restrictive than the missing completely at random assumption.

Three tests, described below, will determine whether the data are missing completely at random and help determine which missing values analysis method is most appropriate.

5.2.3.1 Missing Value Pattern Analysis

The first step is to describe the pattern and amount of the missing data. Six of the eight independent variables have missing values, ranging from 1.8–20% of the total values for each variable, as presented in Table 11. Table 13 presents the pattern of this missing data.

One country with complete dependent variable data, Monaco, was dropped from the dataset because of an unacceptable amount of missing data. Data for seven of the eight independent variables (88%) are missing, which exceeds the acceptable maximum amount of missing data.

Table 13: Missing data patterns Analysis Results

# of cases	Missing Patterns									Complete if…[b]
	Percent Hazardous Waste Exports[a]	Human Development Index	Trade Extent	Trade Structure	Trade Openness #1: Fraser Institute Index	Trade Openness #2: Heritage/WSJ Index	Democracy	NGOs/capita	Technology Development Support	
42										42
7									X	49
1								X	X	51
1								X		43
1					X			X		44
2						X	X	X	X	53
1				X		X	X	X	X	54

[a]variables are sorted on missing patterns;
[b]number of complete cases if variables missing in that pattern (marked by X) are not used.

The tabulated-patterns table shows that these data tend to be missing for multiple variables in individual cases and are therefore jointly missing. All dependent and independent variables are included, and the variables are sorted by missing value patterns. There are no missing data in 42 of the cases. One pattern, where the technology development support variable data are missing, occurs in seven cases. The two trade

openness variables, the level of democracy variable and the technology development support variable data, are missing jointly in two cases. The remaining four patterns are only missing data in one case. The missing value patterns analysis suggests that the data are not missing completely at random.

5.2.3.2 *t*-Test for Variance of Means

Separate-variance *t*-tests indicate that the pattern of missing values of some variables may be influencing the quantitative variables. The means of two variables are compared using the Student's *t*-test statistic, and the test specifies whether the indicator statistic is present or missing. For this analysis, indicator variables are those that have >1% missing values, totaling six variables. When the indicator variable is missing, the mean of the other variables will be different than the mean when the indicator variable is not missing. The missingness of several of the indicator variables seems to be influencing the mean of several of the variables, indicating that the data may not be missing completely at random. As an example, when the trade openness #1 (Fraser Institute) variable is present, the mean of the trade structure variable is 95.33; when the trade openness #1 variable is missing, the mean of the trade structure variable drops to 77.33.

5.2.3.3 Little's MCAR Test

Roderick Little developed a chi-square statistic to determine whether missing values are missing completely at random (Little and Rubin, 1990). The tabulated missing data-patterns table and the *t*-test for variance of means indicate that the data are not missing completely at random. Little's MCAR Test can confirm these results by testing the null hypothesis that the missing values are missing completely at random and the *p* value is significant at the .05 level. The EM analysis was run for 100 iterations to ensure convergence. For the study dataset, the chi-square (χ^2) equals 93.744, $df = 39$, and the sig.=.000. Because this is <.05, the null hypothesis is rejected and the data are found to be not missing completely at random. The results of Little's MCAR test confirm the conclusion drawn from the descriptive statistics and tabulated missing value patterns that the missing data are not MCAR.

All three of the diagnostic tests indicate that the data are not missing completely at random, indicating listwise deletion, pairwise deletion, and regression estimation are not appropriate methods for dealing with the missing values in the research dataset. The three diagnostic tests do not indicate whether the data are missing at random or not missing at random. EM and multiple imputation are appropriate methods for estimating these two types of data.

5.2.4 Selection of a Missing Values Estimation Method

EM will impute a single new dataset based on the relationships observed among the existing data points that contains no missing values. This dataset will contain a degree of random error attributable to the uncertainty of the imputed data. EM may underestimate the standard errors and overestimate the level of precision.

Multiple imputation provides multiple estimates that are pooled to give a more accurate estimation than the single imputation of the EM method. Numerous authors have shown that multiple imputation is superior to other missing values procedures in producing less biased results (Acock, 2005; Allison, 2000; Little & Rubin, 1990; Raghunathan, 2004; Schafer and Olsen, 1998; Scheffer, 2002; Schlomer, Bauman, & Card, 2010; von Hippel, 2004). Multiple imputation creates a number of imputed datasets and can estimate standard errors that are unbiased. When statistical analysis is conducted on the multiply imputed datasets, each of the imputed datasets is analyzed and the results are pooled (Figure 5). The pooled results allow incorporation of missing data uncertainty, allowing for better parameter estimates and unbiased standard errors. The diagnostic tests confirmed multiple imputation is an appropriate method for estimating the missing values; therefore it was the method by which the missing independent variable values were estimated for the research dataset.

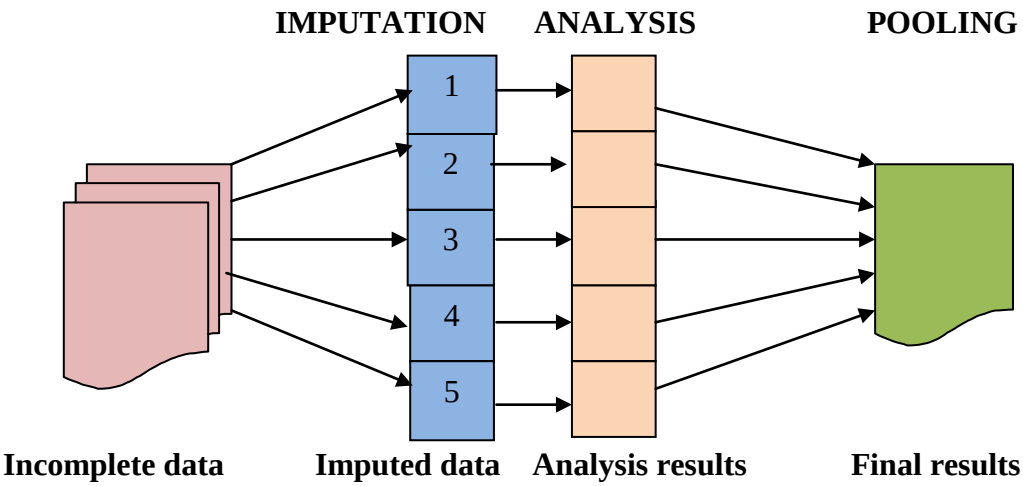

Figure 5: Schematic of multiple imputation process (after http://multiple-imputation.com)

5.3 Multiple Imputation

Multiple imputation is a tool for dealing with missing information in datasets; however, until about 15 years ago, it was a difficult tool to use because of the lack of computational methods for creating the imputed datasets. More general-use multiple imputation software is now available, making the use of this method more feasible. The PASW SPSS Statistical Package 18, combined with the PASW Missing Values 18 module, was used to conduct these analyses. The PASW Missing Values 18 module provides the ability to conduct both single- and multiple imputation analyses, a function that has only been available since 2008.

Multiple imputation uses the random variation in a dataset to generate a model that imputes, or fills in, missing values. This is done a number of times to produce multiple complete datasets, with three to five imputations being recommended as sufficient (Schafer, 1997). The statistics of interest are performed on each of the datasets, with the results pooled to produce a single-point estimate. Standard errors are calculated from the multiple estimates.

5.3.1 Addition of Variables to Imputation Model

In order to create a rich imputation model, it is important to have a large number of associations to facilitate the derivation of the imputed datasets. Twelve additional variables, chosen because of relevance to the outcome variable, provide these associations and help to improve the precision of the imputation model (Table 14). These variables were not used in the regression analysis model, but inclusion of these variables benefits the imputation model by helping to account for the missing value patterns and improve the prediction of the missing values (Schlomer et al., 2010). Schafer (1997) suggests that any relationship that may be important in the future analyses be present in the imputation model and, the larger the variety of relationships included, the broader the variety of future analytical procedures that may be used.

Table 14: Data sources for additional variables used in multiple imputation analysis

Variable Description	Data Source
Hazardous waste generated	Amount of hazardous waste generated in 2006, in metric tons, as reported in the Basel Convention National Reporting Database: http://www.basel.int/natreporting/cfs.htm
Hazardous waste exported	Amount of hazardous waste exported in 2006, in metric tons, as reported in the Basel Convention National Reporting Database: http://www.basel.int/natreporting/cfs.htm
Total exports	Value of merchandise exports for 2006, in U.S. dollars at current prices and exchange rates, as reported in UNCTAD 2009 online database: http://stats.unctad.org/Handbook/TableViewer/tableView.aspx
Gross Domestic Product	GDP in current US $'s for 2006 from World Data Bank: http://search.worldbank.org/data?qterm=GDP+2006&language=EN&format=html
Total number of NGOs per country	Number of total NGOs registered with the World Association of Non-Governmental Organizations (WANGO) database (2010 data): http://www.wango.org/resources.aspx?section=ngodir
Total population	Total estimated population for mid 2006, from World Bank: http://data.worldbank.org/indicator/SP.POP.TOTL
CO_2 emissions per capita	Metric tons of CO_2 emissions per capita, per country for 2006: http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

Urban population	Urban population, % of total in 2005, UNDP 2007: http://hdr.undp.org/en/media/HDR_20072008_EN_Complete.pdf
Population density	Population density (people per square kilometer) in 2006, UNEP Geodata portal data: http://geodata.grid.unep.ch
Geographic size	Geographic size of country in square kilometers from CIA World Fact Book (date not applicable) https://www.cia.gov/library/publications/the-world-factbook/rankorder/2147rank.html
Corruption Perception Index	Transparency International Corruption Perceptions Index 2006 http://www.transparency.org/policy_research/surveys_indices/cpi/2006
Number of environmental treaties ratified	Number of major international environmental treaties ratified as of 2007, from Human Development Report 2007-2008: http://hdr.undp.org/en/media/HDR_20072008_EN_Complete.pdf

5.3.2 Transformation of Variables

To use multiple imputation correctly, the population of the dataset should approach normality, with heavily skewed variable distributions being transformed to achieved a greater level of normality. Schafer and Olsen's (1998) experience shows that multiple imputation is not very sensitive to departures of normality of the data. For the multiple imputation procedure, the following variables were transformed to approach normality.

Table 15: Transformations of variables used in multiple imputation analysis
(Y = logarithmic transformation, N = no transformation)

Variable	ln transformation
Hazardous waste generated	Y
Hazardous waste exported	Y
Percent hazardous waste generated that was exported	N
Human Development Index	N
Total exports	Y
Gross Domestic Product	Y
Trade Extent/GDP	Y
Trade Structure	N
Trade Openness #1: Fraser Institute	Y
Trade Openness #2: Heritage Foundation/WSJ	N
Level of Democracy	N
Total number of NGOs per country	Y
NGOs /capita	Y
Technology Development Support/GDP	Y
Total population	Y
CO_2 emissions/capita	Y
Percent Urban population	N
Population density	Y
Geographic size	Y
Corruption Perception Index	Y
Number of environmental treaties ratified	N

Bold indicates dependent and independent variables used in regression analyses

5.3.3 Pre-imputation Diagnostics

The data patterns are analyzed on the expanded dataset containing the transformed auxiliary variables, prior to performing the imputation. Table 16 is a summary of the independent variables and additional variables with missing data, sorted by amount of missing data, along with the variable mean and standard deviation. Thirteen variables have missing values ranging from 1.8–20.0 %, with six variables having greater than 5%, Schafer's (1997) missing value cutoff for using listwise deletion.

Table 16: Summary of variables missing data for dataset to be imputed
(transformed and untransformed values)

Variable Summary [a]					
Variable	**Missing**				
	N	**Percent**	**Valid *N***	**Mean**	**Standard Deviation**
ln(Technology Development Support/GDP)	11	20.0 %	44	.0391	1.26292
ln(Trade Openness #1: Fraser Institute)	6	10.9 %	49	1.9858	.09941
ln(Corruption Perception Index)	3	5.5 %	52	1.6097	.43787
Level of Democracy	3	5.5 %	52	6.9788	1.97500
Trade Openness #2: Heritage Foundation/WSJ	3	5.5 %	52	75.765	9.6913
ln(Hazardous waste exported)	3	5.5 %	52	9.1562	2.85488
Percent Urban Population	2	3.6 %	53	68.796	18.0485
ln(NGOs /capita)	2	2.6 %	53	-11.8659	1.50784
Total number of NGOs/country	2	3.6 %	53	4.2688	1.59336
ln(CO_2 emissions/capita)	1	1.8 %	54	1.7123	1.11113
ln(Trade Extent)	1	1.8 %	54	-1.0807	.69585
ln(Gross Domestic Product)	1	1.8 %	54	25.2870	1.99629
Human Development Index	1	1.8 %	54	.86450	.114505

[a]Minimum percentage of missing values for variable to be included: 1.0%.
Variables in **bold** are independent variables included in the regression analysis.

The pie charts in Figure 6 indicate that 13 of the 21 variables in the research dataset

(Table 15) have incomplete data, including seven of the eight independent variables.

These missing data are contained in 14 of the 55 cases (countries). This equates to approximately 3% missing values overall. The concern is not the total percentage of missing values, which is small, but the number of cases these missing values are distributed over. Using a method such as listwise deletion on the dataset including the auxiliary variables will cause the loss of approximately 25% of the cases, resulting in a considerable reduction in countries included in the analysis.

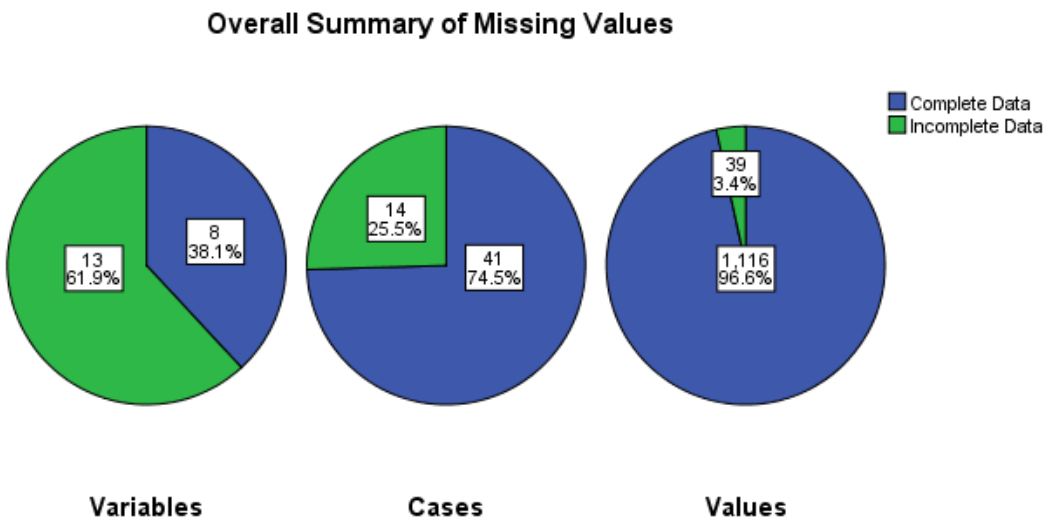

Figure 6: Summary of missing values in multiple imputation dataset depicted by variable, case, and total number of values

The pattern of missing data for the research dataset is presented in Figure 7. The data are sorted by patterns of variables that contain missing values, starting with the patterns that contain the least and increasing to those patterns that contain the most. As shown in Figure 8, pattern #1 indicates that over 70% of the dataset does not have any missing

values. Pattern #4 [missing ln(RDGDP)] contains about 15% of the cases, with all other patterns of missing values containing about 1% of the cases. The missing pattern analysis suggests that missing values are not missing at random, which supports the use of multiple imputation.

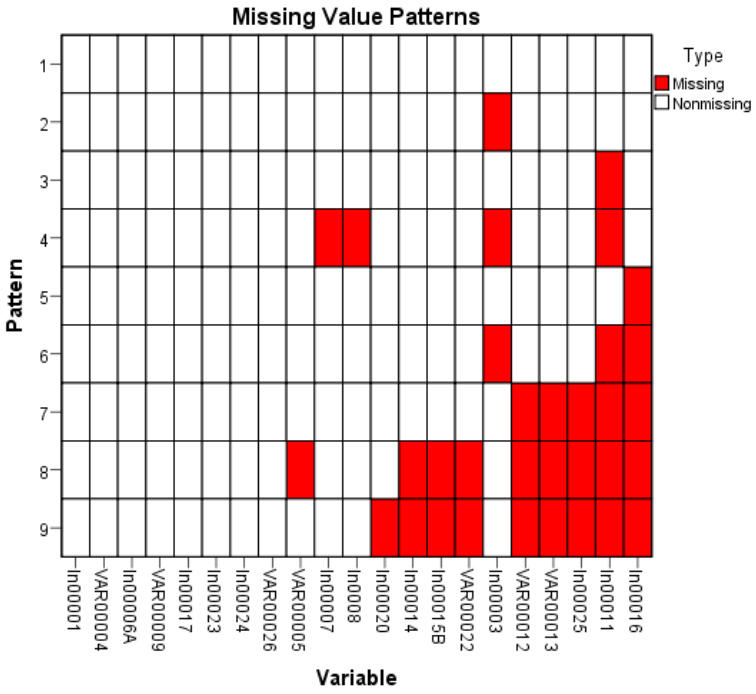

Figure 7: Missing Value Patterns Table,
ordered by increasing missing values for each variable
(Pattern does not indicate complete monotonicity)

The Missing Value Patterns diagram (Figure 7) orders the data to reveal any monotonicity. This evaluation helps determine which type of multiple imputation method is most appropriate. Each pattern corresponds to a group of cases with the same pattern of incomplete and complete data. Variables are ordered left to right in increasing

order of missing variables to reveal monotonicity. If it is monotone, there will be no missing values in the upper left-hand corner and no nonmissing values in the lower right-hand corner. All missing and nonmissing cells will be contiguous. The research dataset is close to a monotone pattern, but the cells are not contiguous; therefore, this dataset is not considered monotone for imputation purposes (Figure 7).

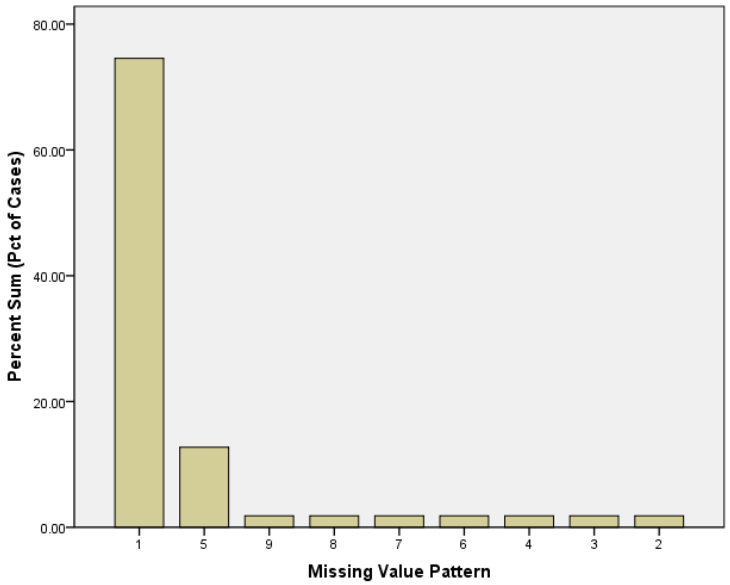

Figure 8: Frequency of missing value patterns, as indicated in the Missing Value Patterns Table (Figure 7)

None of the descriptive statistics indicate any obstacle to multiple imputation. The Missing Value Patterns Table indicates that the monotone-imputation method is not the best choice.

5.3.4 Conducting the Multiple Imputation

Multiple imputation uses the random variation in a dataset to generate a model that produces multiple datasets. In order to be able to replicate the imputation results, it is important to keep the initialization value for the random-number generator constant, as well as the input order of the cases and the variables, and the same procedure settings. By choosing the same initialization value for the random-number generator, the same randomized results can be reproduced. For this study, a random seed of 99 was chosen.

The Fully Conditional Specification (FCS) method was chosen to compute the missing values, using the Markov chain Monte Carlo method. The FCS method uses an iterative process to fit a single dependent model using all the other variables as independent predictor variables, imputing values for those missing in the variable being analyzed. This process is repeated for each variable during each of the iterations until the maximum number of iterations is reached, which in this research was set at 500 to achieve convergence. FCS method can be used when the pattern of missing data is monotone or nonmonotone.

Five imputations were run on the original dataset. The number of imputations can vary; however, five to ten are commonly created (Horton and Kleinman, 2007). Schafer and Olsen (1998) show that gains in efficiency of the estimates diminish after the first few imputations. For a dataset with 10% missing information, which is higher than the 3.4%

missing values in the research dataset, indicated in Figure 5, Schafer and Olsen (1998) show that 98% of the efficiency is achieved after five imputations. Raising the number of imputations will raise this percentage slightly, but Schafer and Olsen (1998) state, "there is simply little advantage to producing and analyzing more than a few imputed databases" (p. 549). The statistical analysis is performed on each of the imputed datasets, and a pooled result is reported. It is not intended that each of the results of the individual imputation be evaluated, as the pooled results are a more accurate representation of the results.

Constraints were placed on the imputation process to restrict the role of a variable during the generation of the missing values and to allow the estimation of appropriate values. For variables that have determined ranges, minimum and maximum values were defined. Untransformed independent variables with missing values for which ranges were defined included the following:

Human Development Index:	0.0 – 1
Trade Openness Index #2:	0.0 – 100
Index of Democracy:	0.0 – 10
Urban population, as percent of total:	0.0 – 100

If the imputed value does not fit within this range, another draw is conducted until an appropriate missing value is determined. In order to insure adequate draws were

available to find these appropriate values, 5,000 case draws and 1,000 parameter draws were specified for this analysis. No rounding of variable values or exclusion of variables on the basis of the amount of missing data were defined. All variables were used as both dependent and independent variables during the imputation process, as is normally the case in these analyses. Also, the FCS convergence charts for the mean and standard deviation of each variable determined that adequate convergence was achieved.

5.3.5 Limitations of Multiple Imputation

When conducting statistical analysis, the imputed data are treated as real data, which may assume a higher precision than actually exists (Little & Rubin, 1990). According to Schafer & Olsen (1998), multiple imputation requires the acceptance of assumptions, including the distribution of the data and the mechanism by which the data are missing. If the data are skewed, they may need to be transformed to approximate a normal distribution. Multiple imputation, however, has been shown to be tolerant to deviations to the assumed distribution (Schafer & Olsen, 1998). To determine if multiple imputation is the appropriate methodology to generate missing data, diagnostic tests should be conducted to determine whether the data are missing completely at random, missing at random or not missing at random as described in Section 5.2.4.

5.4 Statistical Analysis

Statistical analysis was conducted to determine which predictor variables, in this case social, economic, political, or technological factors, may be correlated with higher percentages of hazardous waste exports. Multivariate-linear regression was conducted to determine the predictive capability of the independent variables in relation to the dependent variable. Multivariate regression is the appropriate test to conduct for an experimental design for a dataset of continuous data with one dependent variable and multiple independent variables that meet the assumptions for parametric tests.

5.4.1 Multivariate Regression Modeling

Ordinary least-squares-regression analysis was conducted using the five datasets generated through the multiple imputation process, and the results were pooled. Certain statistics are not pooled because there is currently no consensus on rules to combine these individual values or it is not statistically appropriate to do so. For these statistics a range of values for all five imputations is presented. For example, the unstandardized coefficients and significance levels are pooled after analysis of the five imputations, whereas the R^2, F values, and standardized coefficients are not pooled and are reported as ranges.

5.4.2 Investigation of the Dataset

As important as the inclusion of the correct independent variables is to the analysis, so is the correct choice of regression method. Various methods of conducting the multivariate linear regressions were considered, including the enter, forward and backward stepwise methods. The enter method regresses all the independent variables on the dependent variable without the specification of theoretical importance of specific variables. An a priori decision as to the order of entry into the model is not necessary. On the basis of previous knowledge and a search of the literature, the eight independent variables listed in Table 10 are identified as potential predictors of the dependent variable.

The enter regression presents data on all the independent variables, even those whose coefficients are not significantly different from zero. Variables may be indicated as nonstatistically significant for a number of reasons. For example, there may be no relationship between the variables, or, if the sample size is small, the analytical test may not be able to detect the relationship. If the range of values in a variable is limited, there may not be much of a relationship between variables over the limited range. Due to the relationship of the independent variable to other variables in the model, the information the variable contributes may already be included and therefore not reported during a stepwise regression.

With the use of a stepwise approach, the predictive variables would be added to or subtracted from the regression model on the basis of purely mathematical criterion, without consideration to the theoretical importance of each individual variable. With the use of a forced-enter method, the order of the introduction of the independent variables into the model is determined on the basis of prior knowledge. On the basis of these considerations, the enter method was chosen as the primary regression method, assuming no specific order to the addition of all the variables to the model.

5.4.3 Regression Model Diagnostic Methodology

5.4.3.1 Overall Model Fit

After the enter regression was run, the fit of the model overall was determined through an analysis of the significance of the *F*-ratio determined by the regression ANOVA. The null hypothesis states that none of the independent variables affects the dependent variable, with the alternative hypothesis stating that at least one independent variable affects the dependent variable.

Null hypothesis: $B_1 = B_2 = B_3 = \ldots B_8 = 0$

Alternative hypothesis: At least one of $B_1, B_2, \ldots B_8$ does not equal 0

If the significance of the *F*-ratio is $p < .05$, the null hypothesis will be rejected, indicating that the independent variables are not random with respect to the dependent variable.

The R^2 value indicates the proportion of the variance explained in the dependent variable by the predictors contained in the model. Independent variables can be statistically significant yet only explain a small portion of the variation of the model.

5.4.3.2 Outliers

To determine whether the data from any of the countries cause it to be an outlier, the standardized residual (zresid) values are examined. On the basis of a normal distribution, Field (2009) states that 99.9% of zresid values lie between -3.39 and +3.39. Zresid values greater than the absolute value of 3.39 are unlikely to occur by chance and are cause for concern as possible outliers.

5.4.3.3 Influential Cases

To determine the influence of one case on the model, the Cook's distance and leverage statistics are considered. Cook's distance values greater than 1 are cause for concern (Field, 2009). Leverage statistics also measure influence, through a comparison of the influence of the observed dependent variable value to the predicted values. The average

leverage value is $(k + 1)/n$, where k is the number of independent variables and n is the number of cases. Influential cases are considered those that are either two or three times this average (Field, 2009). For this research dataset, $(k + 1)/n = .163$. Therefore, countries with values greater than .32-.49 are potentially influential cases.

5.4.4 Regression Model Assumptions

In order to draw conclusions on whether the results of the regression analysis are applicable to larger population, it is necessary to meet several assumptions.

- *Linearity*: indicated by linearity of the scatterplot of the regression standardized residual (zresid) vs. the observed values of the dependent variable

- *Constant variance*: indicated by randomness of the scatterplot of the regression standardized residual (zresid) vs. the regression standardized predicted (zpred) value. A nonlinear distribution may indicate heteroscedasticity, or unequal variances, of the residual terms at each level of the independent variables.

- *Collinearity*: serious concern indicated by tolerance levels of <.10, Variance Inflation Factor (VIF) values >10 and Pearson correlation coefficients > .90 (Field, 2009)

- *Independent residuals*: indicated by Durbin-Watson test for autocorrelation

- *Normality*: indicated by histogram of the frequency of regression standardized residuals and the normal *P-P* plot of the regression standardized residual (expected cumulative probability vs. the observed cumulative probability) (Bowerman & O'Connell, 1990)

If the regression assumptions are not met, it may not allow generalization of the model beyond the research sample. For this research, this would mean that the results may not be applicable to countries that were not included in the dataset as a result of incomplete annual reporting or nonratification of the Basel Convention.

Chapter 6: Analysis and Results

6.1 Use of Multiple Imputation Dataset and Pooled Results

The five imputed datasets were analyzed during the regression analysis, and the pooled results were evaluated. The results from the individual imputations were not considered unless the particular statistical function was not pooled, in which case the range of values from the five imputations was reported.

6.2 Discussion of Regression Models

6.2.1 Enter Regression Model

The Enter regression method, with one dependent variable representing the national propensity to export hazardous waste and eight independent predictor variables, was run using the five imputed datasets. To better approximate a normal distribution, four of the independent variables were logarithmically transformed as indicated in Table 15.

6.2.1.1 Enter Regression Model Diagnostics

The overall model fit is good: $F(8,46) = 4.186 – 5.471$ (range), $p < .001$. No outliers are indicated, and there is one possible influential case, Kiribati, with a Cook's distance of > 1 and leverage values of > 0.49 in all five imputations. During the analysis phase of this research, it was determined through regression analysis that the removal of Kiribati did not significantly change the beta coefficients or the significance of the independent variables; therefore Kiribati is included in the dataset, keeping the *n* at 55.

6.2.1.2 Regression Model Assumptions

Linearity: The scatterplot of the standardized residual (zresid) vs. the observed values of the dependent variable (Figure 9; dependent variable is percent of hazardous waste that was exported, HWPER) indicates a linear relationship although there is a grouping of countries at the 0% (all hazardous waste is dispositioned within a country) and 100% (all waste is exported) levels.

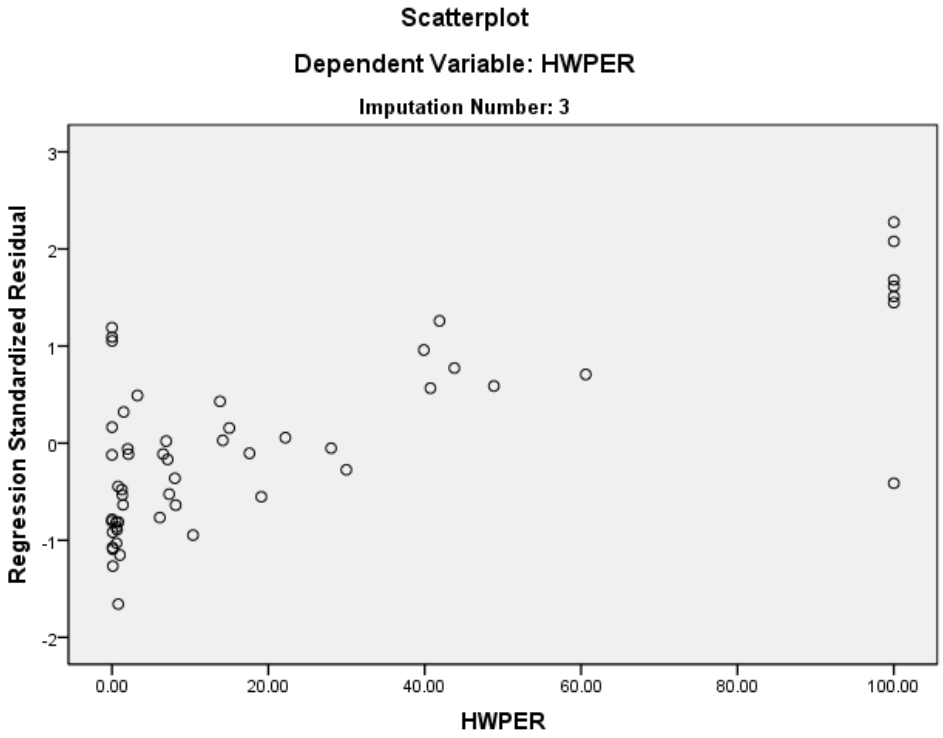

Figure 9: Linearity: Scatterplot of regression standardized residuals (zresid) vs. observed values of the dependent variable

Constant variance (homoscedasticity): A scatterplot of the regression standardized residuals vs. the regression predicted values (Figure 10) indicates that there may be a deviation from constant variances and departure from uniform scatter of the variance. Transforming the dependent variable is one solution to heteroscedasticity. Allison (2000) observes that, in order to create significant bias in the standard error, heteroscedasticity needs to be severe. Allison also notes that transforming the dependent variable alters the relationship between the predictor variables with the outcome variable, making the interpretation of this relationship more difficult to understand.

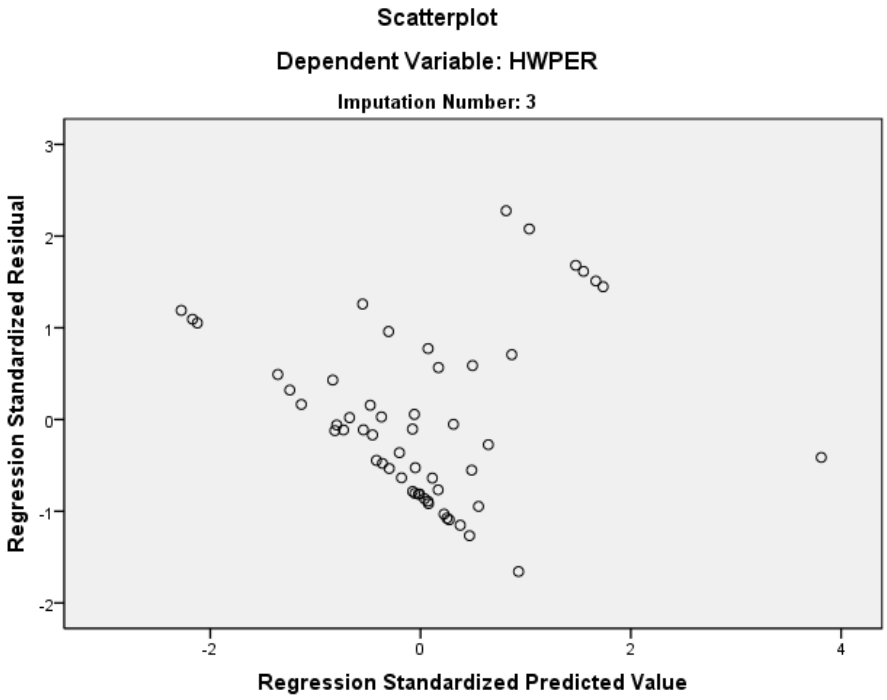

Figure 10: Constant variance: Scatterplot of regression standardized residuals (zresid) vs. regression standardized-predicted values (zpred)

Multicollinearity: The existence of collinearity was examined three ways. The tolerance statistic is not pooled when using multiply imputed datasets so all tolerance values were evaluated. For the regression model, within the five datasets there are no values that are < .10 and only five tolerance values that are < .20, indicating no strong evidence for multicollinearity. The VIF is the reciprocal of the tolerance, and values above 10 indicate a concern about a strong linear relationship and resulting multicollinearity (Field, 2009). Bowerman and O'Connell (1990) posit that an average VIF value substantially above 1 may indicate that multicollinearity is biasing the regression model. Averages for unpooled VIF values for five imputations range from 2.45– 4.35. A Pearson correlation

coefficient of .90 is an indication of a strong bivariate relationship, or multicollinearity (Bowerman & O'Connell, 1990). There are no correlation coefficient values >.70 (Table 17), indicating that multicollinearity is not a serious concern. The Pearson correlation coefficients, tolerance values, and VIF values indicate that a low level of multicollinearity may be influencing the analyses. Bowerman and O'Connell (1990) caution against removing an independent variable in order to reduce the multicollinearity, as the data from this variable will be lost and could potentially be important in predicting the outcome variable.

Independence or autocorrelation: The Durbin-Watson (d) statistics are not pooled when calculated from imputed datasets, and a range of 1.943– 2.177 was indicated. For a probability of a Type 1 error = .01, $n = 55$, $k = 8$ (# independent variables excluding constant/intercept), $d_{Lower, alpha} = 1.095$ and $d_{Upper, alpha} = 1.734$.

H_0: error terms are not autocorrelated

H_1: error terms are positively autocorrelated

If $d < d_{Lower,alpha,}$	reject null hypothesis
If $d > d_{Upper, alpha}$	do not reject null hypothesis
If $d_{Lower, alpha} <= d <= d_{Upper, alpha}$	test is inconclusive (Bowerman & O'Connell, 1990)

The null hypothesis is not rejected, and the error terms are not autocorrelated.

Table 17: Pearson correlation coefficients for enter regression model

Pearson Correlation Coefficients - Enter regression (dependent variable = HWPER)								
	Human Development Index	**ln(Trade Extent)**	**Trade Structure**	**ln(Trade Openness #1: Fraser Institute)**	**Trade Openness #2: Heritage Foundation /WSJ**	**Level of Democracy**	**ln(NGOs/capita)**	**ln(Technology Development Support)**
Human Development Index	-							
ln(Trade Extent)	.103	-						
Trade Structure	.310	.306	-					
ln(Trade Openness #1: Fraser Institute)	.377	.688	.653	-				
Trade Openness #2: Heritage Foundation/ WSJ)	.548	.247	.302	.481	-			
Level of Democracy	.581	- .030	.505	.379	.650	-		
ln(NGOs /capita)	.533	.128	.168	.318	.589	.587	-	
ln(Technology Development Support)	.602	.346	.587	.547	.318	.384	.267	-

NGOs, nongovernmental organizations; WSJ, Wall Street Journal.

Normality: Almost 40% of the reporting countries reported exports of less than 1% of the total hazardous waste generated, giving the dependent variable residual a distribution that is slightly positively skewed (Figure 11). The *P-P* plot of the regression standardized residual (Figure 12) indicates a fairly normal distribution with the observed probabilities being reasonably close to the expected probabilities line.

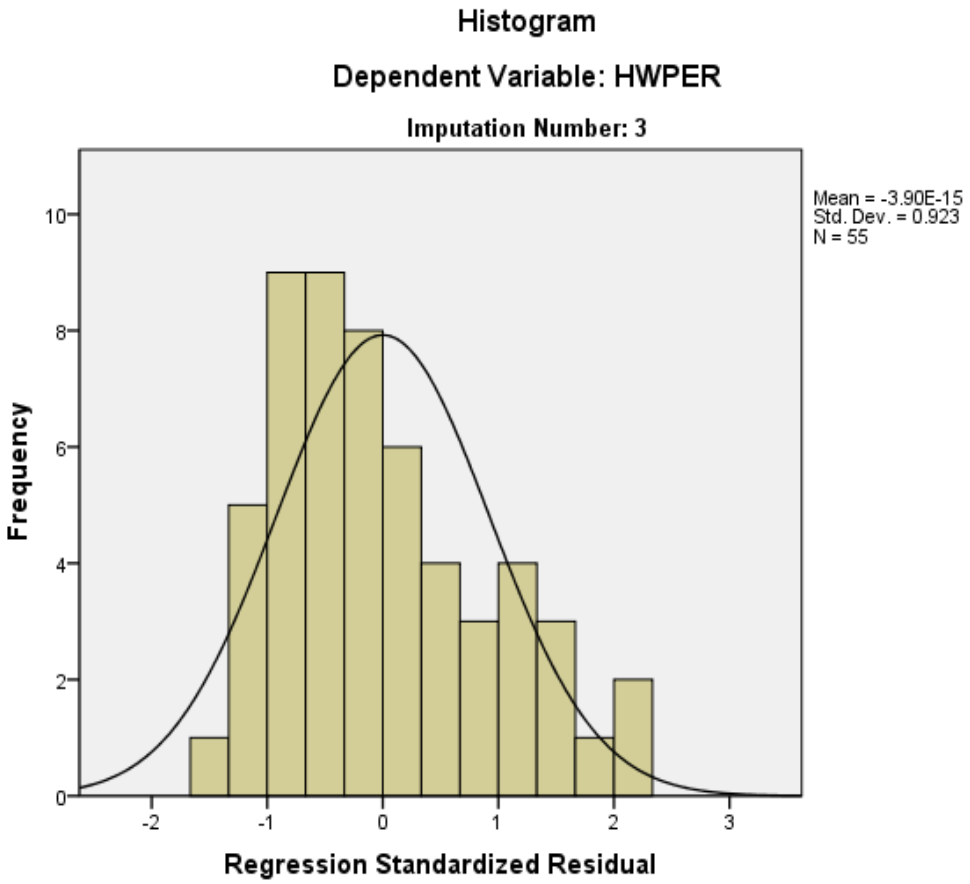

Figure 11: Histogram of regression standardized residuals (zresid)

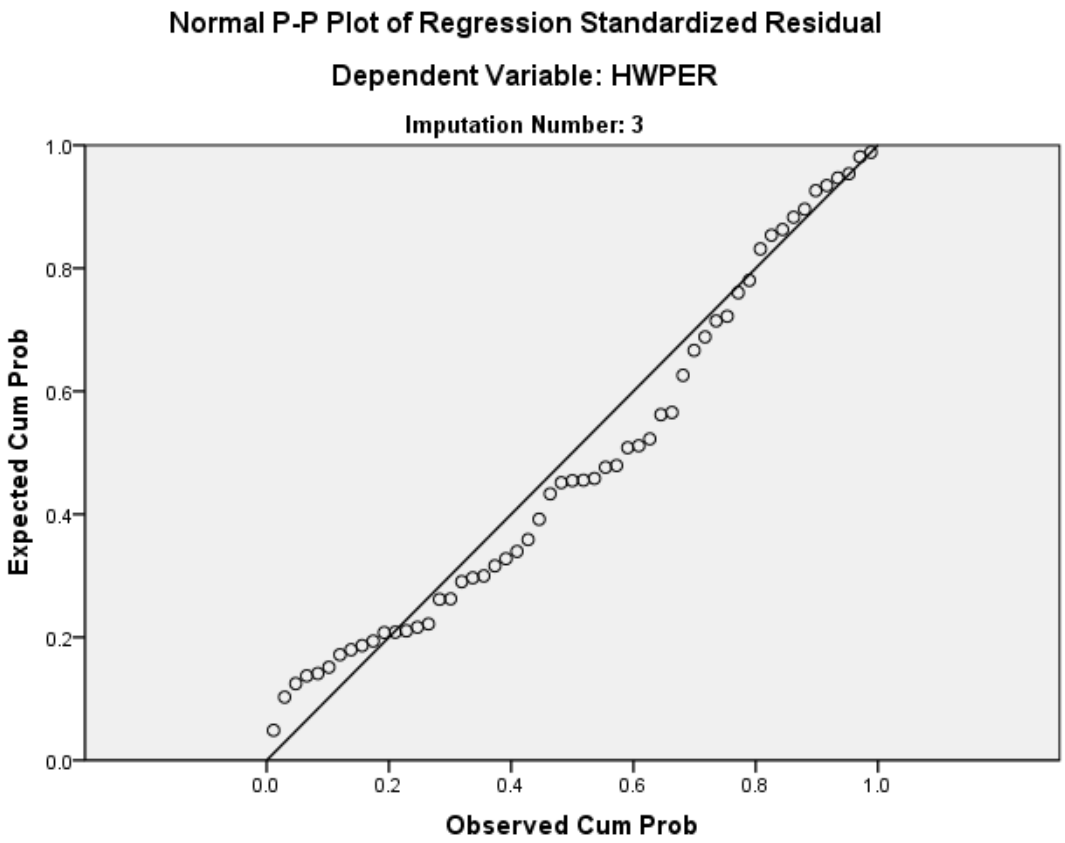

Figure 12: Probability-Probability Plot of expected cumulative probability vs. observed cumulative probability

The tests indicate that the regression assumptions for linearity, independence, and normality are reasonably met. There is an indication of minor multicollinearity and heteroscedasticity.

6.2.1.3 Results of the Enter Regression Model

Enter regression, dependent variable HWPER, with eight independent variables: This analysis (Table 18) determined that one independent variable, the ln (technology

development support) variable, was significant at $p < .01$ (Figure 13). The R^2 range is .421-.544, indicating that approximately half of the variance in the model is explained by the eight independent variables.

Table 18: Enter regression results, with HWPER as the dependent variable and all 8 independent variables included

Enter regression (dependent variable = HWPER) Multiple imputation dataset					
	Unstandardized Coefficients		**Standardized Coefficients**	**t** (pooled)	**sig.** (pooled)
	β (pooled)	**Std. Error** ε (pooled)	**β** (range)		
(Constant)	-44.696	190.505		-.235	.818
Human Development Index	163.616	121.329	.185 - .955	1.349	.223
ln(Trade Extent)	12.201	9.107	.174 - .340	1.340	.183
Trade Structure	-.562	1.017	-.363 - .052	-.552	.589
ln(Trade Openness #1: Fraser Institute)	-22.462	78.219	-.414 - .196	-.287	.778
Trade Openness #2: Heritage Foundation / WSJ)	-.368	.919	-.422 - .099	-.400	.697
Level of Democracy	5.388	5.629	.010 - .675	.957	.363
ln(NGOs/capita)	-1.591	3.952	-.195 - .030	-.403	.689
ln(Technology Development Support)	-14.383	4.368	-.943 - 1.111	-3.292	**.003***

$n = 55$
5 imputations
$F(8,46)$ range = 4.186– 6.863, p range =.000-.001
ε range = .919–190.505
R^2 range = .421-.544
dependent variable: HWPER
*significant at $p < .05$

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \varepsilon$$

HWPER = -44.70 + (163.62 HDI06) + (12.20 ln(TEEXP)) + (-0.56 TSCAT) +
(-22.46 ln(TOFTI)) + (-0.37 TOIEF) + (5.39 DEMEIU) +
(-1.59 ln(NGOPOP)) + (-14.38 ln(RDGDP)) + ε

y = HWPER: hazardous waste generated that is exported (dependent variable)

β_0 = constant

β_{1-8} = partial regression coefficients for eight independent variables

x_1 = HDI06: level of human development

x_2 = ln(TEEXP): ln (trade extent)

x_3 = TSCAT: trade structure

x_4 = ln(TOFTI): ln (trade openness #1- Fraser Institute)

x_5 = TOIEF: trade openness #2- Wall Street Journal/Heritage Foundation

x_6 = DEMEIU: level of democracy

x_7 = ln(NGOPOP): ln (tolerance to civil society)

x_8 = ln(RDGDP): ln (technology development support)

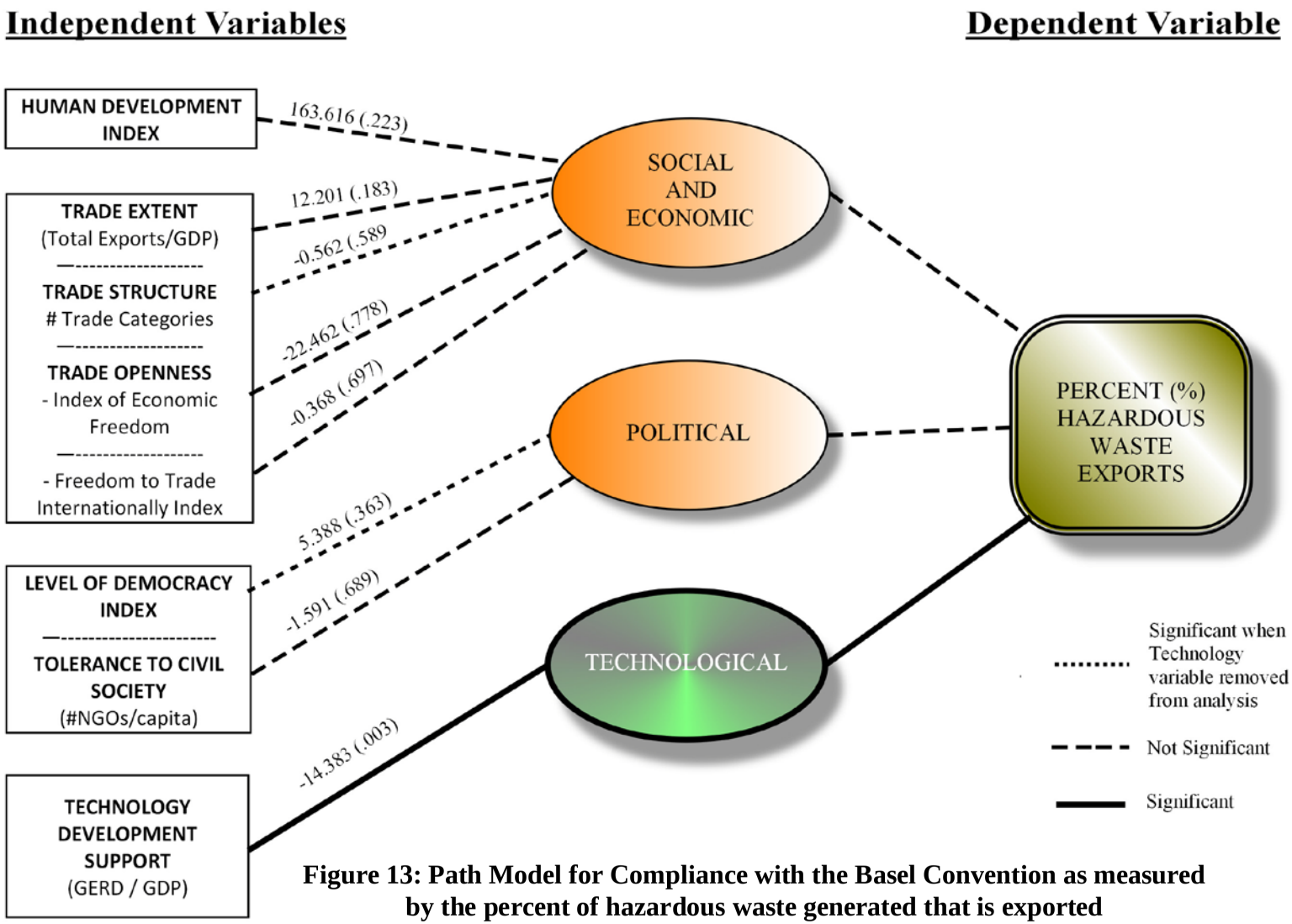

Figure 13: Path Model for Compliance with the Basel Convention as measured by the percent of hazardous waste generated that is exported

Observed relationship: positive (+); inverse (-)

The regression model indicates that there is a negative relationship (β = -14.38) between the ln(technology development support) variable and the outcome variable, percentage of hazardous waste exported. This indicates that, as the ln(technology development support) increases, the percentage of hazardous waste exported decreases. This decrease in waste exports indicates an increase in compliance with the Basel Convention's requirement to reduce transboundary shipments of hazardous waste. This would support Hypothesis H5 that, as technology development support increases, percentage of hazardous waste exported decreases. The remaining social, economic, and political variables are not statistically significant and are not indicated to be good predictors of the outcome variable.

6.2.1.4 Additional Regressions

Deletion of the ln(technology development support) variable: The technology development support variable has 20% missing values. When performing multiple imputation on a dataset, estimates for the maximum acceptable amount of missing data range up to 20% (Peng, Hartwell, Liou, & Ehman, 2007). The ln(technology development support) variable has the most missing values of any of the independent variables and is at the top end of the acceptable range. In order to examine how the results of the enter regression might be altered if this variable was removed from the analysis, the regression was rerun without ln(technology development support). For the

enter regression with seven independent variables, the R^2 range drops to .220-.314, with trade structure significant at p = .028 and level of democracy significant at p = .078 (Table 19).

Table 19: Enter regression results, with HWPER as the dependent variable and the ln(technology development support) independent variable deleted

Enter regression (dependent variable = HWPER, ln(technology development support deleted) Multiple imputation dataset					
	Unstandardized Coefficients		**Standardized Coefficients**		
	β (pooled)	**Std. Error** ε (pooled)	**β** (range)	**t** (pooled)	**sig.** (pooled)
(Constant)	211.832	159.861		1.325	.198
Human Development Index	31.224	48.694	.092 - .193	.641	.521
ln(Trade Extent)	8.484	11.923	.029 - .278	.712	.482
Trade Structure	-1.796	.804	-.611 – (-.366)	-2.235	**.028****
ln(Trade Openness #1: Fraser Institute)	-47.953	81.733	-.431 - .085	-.587	.563
Trade Openness #2: Heritage Foundation/WSJ	-.067	.808	-.205 - .143	-.083	.935
Level of Democracy	6.872	3.890	.367 - .488	1.766	**.078***
ln(NGOs/capita)	-1.044	4.278	-.149 - .031	-.244	.808

n = 55
5 imputations
F(7, 47) range = 1.893–3.075, p range = .009-.092
ε range = .804–159.861
R^2 range = .220-.314
dependent variable: HWPER
*significant at $p < .10$; **significant at $p < .05$

The negative sign of the β coefficient indicates that, as the trade structure of a country becomes more diversified, i.e., the country trades in a larger number of harmonized trade categories, the percentage of hazardous waste exported decreases. Hypothesis H2 predicts, as the trade structure of a country becomes broader, and the number of harmonized categories a country trades in goes up, the country will be more likely to also trade in waste. The β coefficient sign is predicted to be positive, which is opposite from what was statistically determined. However, the statistical result agrees with Neumayer's (2002a) research that correlates increased international trade with greater participation in multilateral agreements. Neumayer posits that this indicates a realization on the part of the government that, in order to participate more fully in global trade, the country may have to make concessions in other policy areas, especially when transboundary issues are in contention.

Enter regression, log transformation of the dependent variable: The distribution of the dependent variable residual has a right skewness, as shown in Figure 11. The log transformation of the dependent variable reduces this skewness. In order to see whether this transformation affects the enter regression results, a regression was run with ln(HWPER) as the dependent variable with all eight independent variables included. Pooled results were obtained, and ln(technology development support) is significant at .060 (Table 20). Therefore, ln (technology development support) is statistically significant whether or not the dependent variable is transformed.

Table 20: Regression results, with ln(HWPER) as the dependent variable and all independent variables included

Enter regression (dependent variable = ln(HWPER)) Multiple imputation dataset					
	Unstandardized Coefficients		**Standardized Coefficients**	**t** (pooled)	**sig.** (pooled)
	β (pooled)	**Std. Error** ε (pooled)	**β** (range)		
(Constant)	.572	8.802		.065	.949
Human Development Index	5.460	4.376	.148 - .595	1.248	.235
ln(Trade Extent)	.617	.471	.171 - .356	1.311	.193
Trade Structure	-.035	.039	-.334 – (-.091)	-.886	.377
ln(Trade Openness #1: Fraser Institute)	-1.528	3.740	-.365 - .169	-.408	.687
Trade Openness #2: Heritage Foundation/ WSJ)	.010	.038	-.195 - .193	.255	.800
Level of Democracy	.350	.208	.302 - .622	1.684	.102
ln(NGOs/capita)	-.020	.189	-.109 - .068	-.105	.917
ln(Technology Development Support)	-.512	.252	-.737 - (-346)	-2.031	**.060***

n = 55
5 imputations
F(8,46) range = 3.573–4.719, *p* =.000-.003
ε range = . 038–8.802
R^2 range = .383-.451
*d*ependent variable: ln(HWPER)
*significant at $p < .10$

The rerun of the enter regression with the transformed dependent variable (ln(HWPER)), but without the ln(technology development support) variable, produced a R^2 range = .262-.358, with level of democracy significant at $p = .028$. Trade structure was significant at $p = .092$. Therefore, level of democracy and trade structure are the only two independent variables with *p* values < .10 when ln(technology development support)

is removed from the analysis, regardless of whether the dependent variable is transformed or untransformed (Table 21).

Table 21: Regression results, with ln(HWPER) as the dependent variable and the ln(technology development support) independent variable deleted

Enter regression (dependent variable = ln(HWPER), ln(technology development support deleted) Multiple imputation dataset					
	Unstandardized Coefficients		**Standardized Coefficients**	**t** (pooled)	**sig.** (pooled)
	β (pooled)	**Std. Error** ε (pooled)	**β** (range)		
(Constant)	9.237	7.542		1.225	.233
Human Development Index	1.027	2.330	.045 - 110	.441	.659
ln(Trade Extent)	.469	.584	.036 - .328	.804	.429
Trade Structure	-.076	.044	-.594 – (-.209)	-1.750	**.092***
ln(Trade Openness #1: Fraser Institute)	-2.369	3.837	-.375 - .079	-.617	.543
Trade Openness #2: Heritage Foundation/ WSJ)	.018	.036	-.012 - .261	.512	.610
Level of Democracy	.398	.181	.479 - .555	2.201	**.028****
ln(NGOs/capita)	-.002	.197	-.069 - .069	-.012	.991

n = 55
5 imputations
F(7,47) range = 2.384–3.746, *p* range =.003-.036
ε range = .036–7.542
R^2 range = .262 - .358
dependent variable: ln(HWPER)
*significant at p < .10, **significant at *p* < .05

Logistic regression: To examine another method for creating a normal distribution for the dependent variable, this variable was converted to a categorical variable, with the intervals selected to approximate a normal distribution. A multinomial logistic regression was run. Rather than predict the value of the dependent variable as in linear regression, logistic regression predicts the probability of the dependent variable occurring given known values of the independent variables. The model was determined to be a good fit; all chi-square likelihood ratio tests are significant at $p = .001$. Using multiply imputed datasets, the statistics program (PASW Statistics 18) does not produce a pooled Wald statistic. The Wald statistic is analogous to the *t*-statistic in linear regression and indicates whether the β coefficient for the predictor is significantly different from zero. When β coefficients are large, as is the case for some of the variables in this analysis, the Wald statistic may have inflated errors and may fail to correctly reject the null hypothesis that each of the individual coefficients in the model are zero (Type II error). Numerous researchers (Field, 2009; Norusis, 2010) recommend using the likelihood ratio tests if there are concerns about the size of the coefficients. The large β coefficients and no pooled likelihood ratios require the evaluation of 20 regression models, making this approach not feasible for multiply imputed datasets. Because the log transformation of the regression standardized residuals in the enter regression model produced a normal distribution, a logistic regression analysis was not deemed necessary.

Listwise deletion: The listwise deletion method for dealing with missing data is commonly seen in the literature. As mentioned in Section 5.2, it is only appropriate

under certain conditions. For the research dataset, the diagnostic statistics determined that multiple imputation was a more appropriate method of missing value analysis because of the type and quantity of the missing values. Strictly for the sake of comparison, the regression was run on a dataset obtained through listwise deletion, using the enter method. The number of cases, *n*, drops to 42, losing data from 13 countries. One significant variable, ln(technology development support) at $p = .003$, was indicated, which corresponded to the variable that was significant using the multiply imputed datasets. The overall fit of the model (F (8,33) = 2.252, $p = .048$) is good, and the $R^2 = .353$. Although the listwise deletion produced a significantly smaller dataset, (ln(technology development support)) is significant at $p < .05$, a result that is similar to the analysis done with the multiply imputed datasets. The trade extent independent variable was significant at the $p < .10$ level (Table 22).

Table 22: Regression results using listwise deletion, with HWPER as the dependent variable and all 8 independent variables included

Enter regression (dependent variable = HWPER) Listwise deletion dataset					
	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**sig.**
	β	**Std. Error ε**	**β**		
(Constant)	8.459	184.357		.046	.964
Human Development Index	112.672	101.442	.375	1.111	.275
ln(Trade Extent)	14.499	7.879	.379	1.840	**.075***
Trade Structure	-.739	1.751	-.075	-.422	.676
ln(Trade Openness #1: Fraser Institute)	-22.685	65.437	-.092	-.347	.731
Trade Openness #2: Heritage Foundation/ WSJ)	-.280	.657	-.105	-.426	.673
Level of Democracy	6.808	4.548	.454	1.497	.144
ln(NGOs/capita)	-.893	3.725	-.051	-.240	.812
ln(Technology Development Support)	-17.291	5.481	-.708	-3.155	**.003****

n = 42
F(8,33) = 2.252, *p* =.048
ε range = .657–184.357
R^2 = .353
dependent variable: HWPER
*significant at *p* < .10, **significant at *p* < .05

No significant variables at the *p* < .10 level were indicated when ln(technology development support) was removed from the regression analysis using listwise regression (Table 23).

Table 23: **Enter regression results using listwise deletion, with HWPER as the dependent variable and the ln(technology development support) independent variable deleted**

Enter regression (dependent variable = HWPER, ln(technology development support deleted) Listwise deletion dataset					
	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**sig.**
	β	**Std. Error ε**	**β**		
(Constant)	75.715	171.869		.441	.662
Human Development Index	-16.598	53.108	-.069	-.313	.756
ln(Trade Extent)	6.916	10.145	.147	.682	.499
Trade Structure	-.863	1.455	-.117	-.593	.556
ln(Trade Openness #1: Fraser Institute)	-8.939	71.516	-.031	-.125	.901
Trade Openness #2: Heritage Foundation/ WSJ)	.223	.706	.076	.323	.748
Level of Democracy	5.917	4.434	.367	1.335	.189
ln(NGOs/capita)	-.375	3.927	-.020	-.095	.924

$n = 49$
$F(7,41) = .693$, $p = .678$
ε range = .117–.367
$R^2 = .106$
dependent variable: HWPER
no significant variables at $p < .10$

6.3 Summary of Regression Results in Relation to the Hypotheses

When regressing all eight independent variables against the dependent variable (HWPER), ln(technology development support) is the only statistically significant

variable. When ln(technology development support) is removed from the analysis, trade structure and level of democracy are identified as being statistically significant at the $p <$ .10, regardless of whether the dependent variable is logarithmically transformed or not. The results of the various regression analyses are summarized in Table 24 and indicate that technology development support, trade structure, and level of democracy are statistical predictors of the level of hazardous waste exports.

Table 24: Summary of Regression Analysis Results

Regression Model Comparisons: Significant variables ($p <$ .10 reported in parentheses)		
	All independent variables	**Technology variable deleted**
Enter regression model (n=55)	**Technology development support (.003)**	**Trade structure (.028)** **Level of democracy (.078)**
Enter regression model: dependent variable log transformed (n=55)	**Technology development support (.060)**	**Level of democracy (.078)** **Trade structure (.092)**
Stepwise backward elimination regression model (n=55)	**Technology development support (.003)**	**Trade structure (.028)** **Level of democracy (.078)**
Listwise deletion using enter regression	**Technology development support (.003)** Trade extent (.075)	No significant variables

The results of the regression analyses, in relation to each of the hypotheses, are presented below. The implications of these results will be presented in Chapter 8.

Hypothesis (H1): As a country's Human Development Index increases, the percentage of its hazardous waste that is exported decreases.

The Human Development Index was used to identify a country's level of development and includes measures of income, education, and life expectancy. This variable was not statistically significant in the regression analysis or any of the exploratory analyses.

Hypothesis (H2): As a country's level of international trade increases, the percentage of its hazardous waste that is exported increases.

Three independent measures of trade were examined: trade extent, trade structure, and two separate measures of trade openness (the freedom to trade internationally). Trade structure, which is a measure of trade diversity, was significant when the technology development support variable was not included in the regression analyses. The analysis indicated that, when the diversity of trade increases, the amount of hazardous waste exports go down (unstandardized $\beta = -1.796$), indicating a higher level of compliance with the Basel Convention. This direction is opposite what was originally predicted by the researcher and Clapp (1994) but agrees with Neumayer (2002a).

Hypothesis (H3): As a country's level of democracy increases, the percentage of its hazardous waste that is exported decreases.

The level of democracy index was significant when the technology development support was not included. As the level of democracy goes up, the amount of hazardous waste exports goes up (unstandardized $\beta = 6.872$), indicating a decrease in the level of compliance with the Basel Convention. This direction is opposite of what was predicted by both the researcher and the literature (Congleton, 1992; Neumayer, 2002b; O'Neill, 1998; Payne, 1995; Torras and Boyce, 1998).

Hypothesis (H4): As a country's level of tolerance to civil society increases, the percentage of its hazardous waste that is exported decreases.

NGOs can be effective in keeping the international spotlight on national policy and in bringing about environmental reform. For example, the Basel Action Network (BAN), an NGO that originated during the Basel Convention negotiations, is very active today in exposing the dangerous trade in hazardous and electronic wastes in developing countries and bringing about regulatory reform in countries. The number of NGOs per capita was not statistically significant in any of the regression analyses.

Hypothesis (H5): As a country's level of technology development support increases, the percentage of its hazardous waste that is exported decreases.

Technology development support was the only statistically significant variable in the regression analyses in which all eight independent variables were analyzed. As a country

devotes more of its GDP to R&D, the amount of hazardous waste exports decreases (unstandardized $\beta = -14.383$), indicating greater compliance with the Basel Convention. This decrease in exports may be the result of its in-country waste management through development of waste minimization, treatment, and disposal technologies.

Table 25 summarizes the predicted variable coefficient sign as compared to the statistically observed sign, noting whether the relationship was positive or inverse.

Table 25: Comparison of predicted variable coefficient signs with observed coefficient signs for dependent variable

	Variable Information		β Coefficient Sign indicates positive (+) and inverse (-) relationships		
	Independent Variable	**Variable Category**	**Predicted by Hypotheses**	**Predicted by Literature**	**Observed**
Hypothesis 1	Human Development Index	Social	–	–	+
Hypothesis 2	Trade extent	Economic	+	–	+
	Trade structure**		+	–	–
	Trade Openness (Fraser Institute)		+	–	–
	Trade Openness (Heritage Foundation/ WSJ)		+	–	–
Hypothesis 3	**Level of democracy****	Political	–	–	+
Hypothesis 4	Tolerance to civil society (# NGOs)		–	–	–
Hypothesis 5	**Technology Development Support***	Techno-logical	–	–	–

*Statistically significant variable
**Statistically significant variable only when technology development support is removed from analysis

Chapter 7: Qualitative Perspectives at the Practitioner Level

The statistical analysis discussed in Chapter 6 examines the issue of hazardous waste exports at the national level because it is the national government that grants the consent to export or import. On the basis of this analysis, technology development support, as expressed by the gross domestic expenditure on research and development per unit of gross domestic product, was the sole statistically significant variable when all eight independent variables were analyzed. If the assumption that some of this support is dedicated to development of environmental technologies, including those related to hazardous waste treatment and disposal, is accepted, this statistical result may indicate that access to these technologies is a predictor of the percentage of hazardous waste exports. Development of waste-related technologies leads to in-country waste management, which is a long-term solution to the reduction of transboundary shipments of hazardous waste and implementation of the Basel Convention.

However, what do the actual government officials responsible for managing transboundary shipments of hazardous waste, the practitioners in the field, see as their greatest need to successful implementation of the Basel Convention? What do these government officials indicate is needed to effectively implement the national level programs, and is the collective action framework explanatory at this practitioner level?

A qualitative analysis, based on a survey of practitioners, was conducted to identify these needs.

7.1 Identifying the Needs of the Practitioners

As discussed in Section 3.8, Ostrom's theory of collective action is different from that of Olson and Hardin, in that Ostrom believes in solving issues as close as possible to those responsible for the resource. In the case of transboundary shipments of hazardous waste, this responsibility lies with the government officials of environmental ministries and customs agencies who implement the Basel Convention. Understanding what these officials perceive as necessary to properly manage shipments of hazardous waste is important in providing specific technical assistance and tools to successfully implement this treaty.

The Seaport Environmental Security Network (SESN) of the International Network for Environmental Compliance and Enforcement (INECE) set out to identify these needs by querying midlevel government officials from environmental ministries and customs agencies. No one individual opinion is conclusive, but, if the opinions of all officials surveyed identify the same challenges and potential solutions, then this information can contribute to necessary policy changes. The information from small-*n* studies may not always be directly applicable to the information obtained in large-*n* studies but does offer

a level of specificity not available from these large-*n*, national-level studies and allows more of the complexity of the issue to be examined (Poteete, Janssen, & Ostrom, 2010).

7.2 Survey Respondents

In 2009 and 2010, INECE prepared and administered a needs assessment survey to officials in two specific geographic areas, Asia and West Africa. Both these regions have been the recipients of unwanted hazardous waste shipments in the past and are still vulnerable to unwanted transboundary shipments of hazardous waste. The enforcement professionals surveyed are responsible for the management of transboundary hazardous waste shipments arriving, exiting, or transiting through their respective ports. Therefore, their perceptions of the issues and challenges reflect a pragmatic view of what is needed to successfully implement the Basel Convention.

In 2009, 38 midlevel managers from West African environmental ministries, customs agencies, and port authorities were surveyed by the INECE SESN. West African countries participating in this assessment, conducted in Accra, Ghana, included Benin, Côte d'Ivoire, Ghana, Nigeria, Senegal, and Togo. In 2010, 17 Asian environmental enforcement officials from Brunei Darussalam, Cambodia, China, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, and Vietnam participated in the assessment conducted at an INECE workshop in Siem Reap, Cambodia. These officials attended the two workshops to share their experiences and

figure out ways to improve their hazardous waste-tracking capabilities, which range from nascent port inspection initiatives to more comprehensive port environmental security programs. The West African survey responses and the Asian survey responses were compiled separately to identify regional opportunities for existing and future SESN tools, resources, and assistance. Tracking of specific country responses was not conducted as a result of this regional emphasis.

The raw data from these surveys were analyzed by the researcher to generate a qualitative assessment of why management of transboundary movement of hazardous waste is such a complex and difficult process to administer. Specific needs and potential solutions that could be implemented through public policy can result from analysis of these data. The responses represent the viewpoints of the individual officials on the basis of their experiences. Similarity of experiences may indicate that a change in public policy is needed.

7.2.1 Design of the INECE Seaport Network Needs Assessment

INECE decided to use a survey instrument to gather information on the needs of environmental ministry and customs officials responsible for transboundary shipments of hazardous waste. Prior to the 2009 and 2010 regional workshops in West Africa and Asia, respectively, participants of the SESN agreed on four areas of environmental enforcement that needed improvement. These areas included: (a) enhancing the ability to

exchange information both nationally and internationally, (b) assistance in interpreting the Basel Convention provisions, as well as national laws, (c) international collaboration between all entities responsible for enforcement at seaports, and (d) increasing the exchange of experiences and knowledge. INECE developed a written survey document to further examine these four areas and obtain specific insights on regional needs. Also, at both the West African and Asian workshops, small focus groups, consisting of 10–12 officials, were held to further enhance discussion of needs. In order to understand how these four environmental enforcement areas could be implemented in the field, the needs assessment incorporated these concepts into four survey areas.

- *Communication*: Being able to communicate between authorities and countries to follow legal and illegal shipments and better understand the transboundary life cycle of hazardous waste from origin to final disposition
- *Capacity building*: Developing and improving the skills and knowledge base of port inspectors and regulators through the use of specific initiatives and tools
- *Collaboration*: Specifically targeting informal cross-border collaboration between officials of enforcement agencies that can help disrupt the illegal hazardous waste trade
- *Port inspections*: Addressing specific obstacles to effective port inspections that can support compliance with the Basel Convention and national hazardous waste legislation

7.2.2 Needs Assessment Survey Results

7.2.2.1 Communication

There is overwhelming agreement in both regions that communication lines need to be established to facilitate the exchange of data. In West Africa, most of the respondents indicate a desire for cross-border communications, in addition to communication at the national level. This most likely reflects concern over the practice of port hopping along the coast of West Africa as a result of the geographic proximity of the ports. Collective action among West African countries is the only effective solution to this problem, for, if one country develops a strong import inspection program with the ability to identify and reject suspect or illegal shipments, the waste shipper will look for another nearby port that will allow the illegal cargo to be off-loaded. Collectively communicating information on these shipments can help alert the other ports to the incoming hazardous cargo.

In Asia, the needs assessment indicated a fairly even division of opinion between the need for communications at the national level, the cross-border/bilateral level, and the regional level. Respondents expressed interest in continuing and improving communications among the Secretariats of the Basel, Rotterdam, and Stockholm Conventions, as well as with regional organizations such as the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Waste, INECE SESN, the

Regional Intelligence Liaison Offices and Customs Enforcement Network of the World Customs Organization. Collectively working with the shipping industry was proposed during the Asian workshop as a possible means of disrupting the illegal waste trade.

In West Africa, respondents prefer information sharing at the shipment/container level, followed by verification requests, which include information on permits, licenses, bills of lading, invoices, manifests, and other container-specific information. Asian seaport officials request updated national contact lists as their number-one need. Language may be a barrier to effective communication; for example, in South East Asia, there are at least twelve primary languages, creating the potential for miscommunication of verbally exchanged data and information. Therefore, e-mail, which provides a permanent record that can be translated, may help overcome language barriers and is the preferred means for sharing information, along with protected websites. The value of personal contacts among enforcement counterparts in other countries is recognized by both regions.

Very little environmental enforcement exists at West African ports, for, although these countries have ratified the Basel Convention, there is inadequate legislative authority, enforcement capacity, and appropriate training and equipment to effectively implement the Convention. Corruption at ports may also be hindering effective enforcement. Using a scale of 0 (highly corrupt) to 10.0 (very clean) to describe the perception of corruption, Transparency International 2006 scores in specific countries range from 2.1 to 3.3 for the participating West African survey respondents and 2.1 to 9.4 for the Asian respondents.

For the Asian respondents, seven of the nine available country scores were in the range of 2.1–3.6, with Malaysia (5.0) and Singapore (9.4) scoring higher (Transparency International, 2010). For comparison, the United States scored 7.3 in 2006.

7.2.2.2 Capacity Building

There was a unanimous call for enforcement of capacity-building activities by both West Africa and Asia. When identifying areas of focus, West Africa highlights waste shipment legislation, interagency collaboration, risk and threat assessments, inspection methods, and inspector exchange programs almost equally. Guidelines and manuals are requested by the West African respondents, particularly relating to shipping container handling. It is suggested that this information could be compiled from existing collaborative activities, resulting in a best-practices guide, which could be disseminated to all interested parties worldwide. When queried about what new tools were needed to enhance capacity building, the West African respondents identify more long-term needs, such as development of international protocols and implementing legislation, as well as hazardous waste management standards and projection of the need for long-term treatment sites.

All Asian respondents indicated a need for capacity building activities, identifying inspection methods and interagency collaboration as the region's top priorities. The

ability to conduct risk and threat assessments and to understand waste shipment regulations are two additional areas identified as needing attention. One issue that receives interest in the Asian region, but not the West African region, is the repatriation or take-back authority, which returns the waste to the exporting country. Identifying what constitutes a waste is a complex process attributable to varying national legislations and an area the Asian survey respondents flag as problematic. Suggested remedies included a waste identification booklet, a training manual on how to distinguish second-hand goods from waste, particularly in relation to electronic waste, quick tools for Harmonized System (HS) waste code identification, and an online database of hazardous waste with HS codes and pictures. A new topic, intelligence-led enforcement, was introduced at the Asian meeting. This technique can be used to selectively target suspect shipments using risk and threat assessments and helps to use limited enforcement resources to the greatest benefit (Maguire & John, 2006; US Department of Justice, 2005). The Asian survey respondents request that intelligence-led enforcement be developed as a new capacity building tool. The successful implementation of intelligence-led enforcement is very much a function of successful collective action, as it can only be accomplished if communication and collaboration between countries is enhanced because intelligence-led enforcement requires the sharing of information between government officials and the conducting of joint operations.

7.2.2.3 Collaboration

The need to intensify cross-border collaboration was identified by all respondents. Both regions identified an active network, with regular meetings, as the vehicle to achieve this collaboration. West African respondents suggest regular telephone conferences to facilitate timely exchange of data, a website, and "task teams" to follow up on issues of common interest. Language barriers in West Africa, where French and English are the primary languages, may hamper telephone conversations. Looking more long term in West Africa, technical support for advanced management of hazardous waste is requested.

The Asian survey respondents also placed a high priority on online and virtual collaboration as well as coordinated enforcement activities, such as the INECE SESN International Inspection Month project, conducted at the international, regional, and domestic level. Regular meetings through an active regional network are seen as a way to learn from each other.

7.2.2.4 Port Inspections

Port inspections represent the enforcement aspect of collective action, what Ostrom, Walker, and Gardner (1992) refer to as the sword of collective action. Although

communication is an important component of effective collective action, this effectiveness is increased when the participants also impose a sanctioning method through enforcement. The range of survey respondents runs from those countries with well-established inspection programs to countries that have much less experience with seaport inspections. However, all respondents indicate that they face obstacles to inspection of hazardous waste shipments at their ports.

West Africa respondents identify lack of capacity as their primary obstacle, followed closely by a lack of collaboration. Also identified was a lack of tools, information and knowledge, and problems with interpretation of laws and waste definitions, listed in order of decreasing importance.

The Asian respondents identify lack of information as their number-one obstacle to effective port inspections, resulting from confusion over waste definitions and a lack of information on wastes imported into their respective countries. Problems with interpretation of laws and definitions, as well as a lack of capacity, training, and collaborative opportunities, are also priorities, listed in order of decreasing importance. Interestingly, there is little priority given to the lack of relevant law as an obstacle to port inspections; however, interpretation of existing laws and definitions is given a high priority.

On the basis of the identified needs at the practitioner level, it appears that the individuals surveyed identified similar constraints to implementation of the Basel Convention and therefore may be able to collaboratively design strategies to overcome these constraints.

7.2.3 Limitations of the Needs Assessment Data

The responses to the needs assessment represent the viewpoints of the individual officials surveyed on the basis of their unique experiences and personal observations and may not necessarily reflect the official position of their governmental agency. The responses may be anecdotal in nature. Moreover, the survey information collected by INECE is geographically specific and limited to the participants of the two SESN workshops, so it may not represent a more global population of government officials. However, even with these limitations, the information gathered during the INECE needs assessment offers a unique view into inspection operations at seaports. The similarity of experiences, challenges, and suggested solutions may indicate that a coordinated regulatory or policy change is needed.

Chapter 8: Discussion

8.1 Challenge of Environmentally Sound Hazardous Waste Management

Managing hazardous waste, through treatment, storage, or disposal, is a difficult challenge from both a science and policy viewpoint. Hazardous waste shipments arrive at global ports every day, and government officials need to properly manage these shipments. The Basel Convention requires advance approval of the shipment by the exporting, importing, and any transit countries through the Prior Informed Consent (PIC) process. This allows the receiving country to reject a shipment it does not have the capability to manage properly, obligating the exporting country to restrict the movement of the shipment. If all transboundary movements of hazardous waste followed the PIC process, countries would multilaterally share in the responsibility to restrict the unwanted shipment of hazardous waste. However, in reality, some movements of waste are not properly identified, either intentionally to avoid detection as a hazardous material or through lack of knowledge concerning the definition of a hazardous waste. Much like the indiscriminant dumping of hazardous wastes in developing countries during the 1970s raised awareness of the hazardous waste disposal issue and triggered national regulatory reforms and an international treaty, the transboundary movement of electronic waste is

now spotlighting this issue. This research looked at the both the long-term needs and the short-term needs for addressing legal transboundary shipment of hazardous waste, using quantitative and qualitative methods respectively. The illegal trade also needs to be addressed, as evidenced by responses to the needs assessment conducted in Asia and West Africa and discussed in Chapter 7.

8.2 Significance of Research and Development Support

The regression analysis supports Hypothesis H5 that states, as a country's level of technology development support increases, the percentage of its hazardous waste that is exported decreases. The research and development (R&D) intensity statistic [gross domestic expenditure on R&D (GERD) as a percentage of gross domestic product (GDP)] was used as a proxy for technology development support, and this is the one independent variable that was determined by this research to be statistically significant. This research assumes that a country's commitment to developing environmentally sound hazardous waste treatment and disposal technologies is reflected in a higher overall expenditure on R&D per unit of GDP.

More stringent restrictions on hazardous wastes destined for landfill disposal and more stringent air emissions for hazardous waste incinerators may encourage the development of innovative on-site waste-treatment processes. To comply with these waste-management regulatory requirements, an investment in the development of treatment and

disposal technologies and facilities, made by the public sector, private sector, or a partnership of both, will need to be made.

GERD represents the yearly amount expended by a country to support R&D and is commonly used as a proxy for innovation as seen in new processes and products. The calculation of GERD/GDP is commonly used to describe differences between countries, as it takes into account the economic size of the country and is a more stable statistic. In 2007 the average worldwide R&D intensity was 1.7%, with a range of 0.02 (Bosnia-Herzegovina) to 4.53 (Israel) % for the countries in the research dataset. In order to become more competitive in a knowledge-based economy, the European Union (EU) set a target goal of 3.0% for 2010 (Westholm, Tchatshoua, & Tindemans, 2004). As of 2008, two EU countries, Finland and Sweden, had achieved a R&D intensity of >3.0%. A summary of R&D intensity for the research timeframe is presented in Table 26.

Table 26: Average Gross Expenditure on Research & Development / Gross Domestic Product (GERD/GDP), 2007

R&D Intensity	
World	
Total	1.7%
Developed Countries	2.3%
Developing Countries	1.0%
Less Developed Countries	0.2%
Regional	
Americas	2.1%
Europe	1.6%
Africa	0.4%
Asia	1.6%
Oceania	1.9%

From: UNESCO (2010) Institute for Statistics

Recent environmental research in the Organization for Economic Cooperation and Development (OECD) is focused on three main issues: mitigation of climate change, control of air and water pollution, and enhancing biodiversity (OECD, 2009). The growth in environmental research activity, as calculated by citations to core scientific articles, into control of air pollutant dispersion, aquatic contamination by chemical contaminants, and pollution caused by persistent organic compounds indicate an increase in interest in reducing the environmental contamination caused by releases from hazardous chemical and hazardous chemical materials and wastes. The current state of the economy may cause a reduction in the funds available for R&D, but it is encouraging that research in the environmental sciences is a priority area for the industrialized countries (OECD, 2009).

When comparing R&D data on an international scale and comparing data from developed and developing countries, Salomon, Sagasti, and Sachs-Jeantet (1994) recommend caution because of availability and quality of the data and making any conclusions concerning the relative R&D performance of developing countries. These cautions still hold true today, as generating and reporting statistics on R&D and innovation are not top priorities for national statistical agencies.

8.3 Significance of Trade Diversity

Hypothesis H2 states that, as the volume of export trade goes up, so will the volume of hazardous waste exports. This hypothesis relates to the willingness and the ability of a country to participate in globalized trade. Because hazardous waste is a commodity, and has a market value, it is hypothesized that it would be traded internationally as any other export. Therefore as volume of international trade goes up, so will volume of hazardous waste exports. This research examined trade in three different ways: trade extent (total exports/GDP), trade structure (number of export categories), and trade openness (freedom to trade internationally).

This research indicates that the actual amount of trade exports is not a significant predictor of hazardous waste exports. The expected relationship of total trade extent to the dependent variable agrees with the analytical result, indicating trade extent is the only trade-related independent variable with a positive relationship with the dependent

variable. As total export trade increases, the volume of hazardous waste exported increases. This is the inverse of the relationship predicted by Neumayer's (2002a) research that states, the more a country participates in globalized trade, the more likely it is to participate in multilateral cooperation in numerous policy areas because of an economic incentive to increase this trade. This analysis indicates that hazardous waste is treated more as a tradable commodity, rather than an environmental liability that could lessen a country's global trading status.

The ability of a country to trade freely, which is related to the number of existing trade barriers, is also not a statistically significant predictor of hazardous waste exports. On the basis of Hypothesis H2, the ability to trade freely was predicted to have a positive relationship with the dependent variable. The statistical analysis indicated an inverse relationship; as a country is more open to global trading, the volume of hazardous waste exports decreases.

When evaluating the independent variables in the absence of the technology development support variable, the trade structure was indicated as a statistically significant predictor of the dependent variable. As the trade structure diversifies, the percentage of hazardous waste exports decreases and indicates that, as a country broadens its export structure, environmental compliance with the Basel Convention increases. This agrees with Neumayer's (2002a) predicted relationship between trade and multilateral environmental cooperation. This also agrees with Roberts, Parks, and Vasquez (2004) who posit that a

diversified export portfolio is necessary for ratification in international treaties, as countries with a restricted number of export trade categories tend to be prone to corrupt and ineffective governments that do not place a high priority on environmental protection. The statistics of this research support the idea that greater integration into globalized trade encourages a country to embrace a greater environmental commitment. However, the distinction between ratification of and participation in international treaties, as examined by Neumayer (2002a) and Roberts et al. (2004), and actual compliance with the rules of the international treaties needs to be clear, as these are different concepts. It is one measure of compliance, relating to the transboundary shipment of hazardous waste, which is examined by this research, as it is compliance that shows a sustained commitment of the country to their responsibilities under the international convention.

8.4 Significance of Level of Democracy

Hypothesis H3 states that a country's higher level of democracy will be reflected in a lower percentage of hazardous waste exports. Level of democracy was statistically significant when the support to technology development was not included in the regression analysis. However, the sign of the coefficient indicates that, when democracy increases, the amount of hazardous waste increases, signaling a decrease in compliance to the Basel Convention. This is opposite of what is expected from a review of the literature, where a higher degree of democracy leads to greater environmental commitment (Congleton, 1992; Neumayer, 2002b; Olson, 1993; Payne, 1995).

Democratic governments are generally more responsive than authoritarian regimes, with greater citizen participation in the policy process, potentially producing an "induced policy response," in the words of Barrett and Graddy (2000). Payne (1995) lists five arguments for democracy, three of which are directly related to citizen input: (1) individual rights and the open marketplace of ideas, (2) regime responsiveness, and (3) political learning. The other two arguments, internationalism and open markets, are primarily trade related, which are examined under Hypothesis H2. Payne's arguments lead one to assume that the strength of democratic process would be a predictor of a country's commitment to complying with environmental international treaties the country has ratified. The Economist Intelligence Unit (EIU) Democracy Index, used in this study, focuses on the first three arguments of Payne, the civil side, and does not measure any concepts relating to internationalism and open markets.

There are a number of reasons why the statistical results are different from the expected results. First, the components of the EIU Democracy Index used in this analysis may be one reason the percentage of hazardous waste exports does not decrease as the level of democracy increases. Further investigation of each of the components of the EIU Democracy Index is warranted to determine if any of these components are statistically significant. Second, the stage of industrial development may be an important consideration when examining countries that have similar democracy indexes. A democratic industrializing country would produce more manufactured or mined goods and therefore produce more waste. If the country cannot provide environmentally sound

management for the waste, it will either be dumped internally or exported. Third, more developed countries may shift their polluting industries to these industrializing countries, as seen in the relocation of U.S. industries into the Mexican border zone. Frey (1998) describes this shift from the core to the periphery as a way of avoiding scrutiny placed on transboundary hazardous waste movements. Fourth, a democratic government may also have a strong business contingent that does not encourage participation in transboundary issues or exhibit a commitment to international agreements if the cost is too high, related to the perceived benefit.

8.5 Other Variables

The level of development and tolerance to civil society independent variables were expected to be predictors of the dependent variable, but the analysis did not indicate statistical significance. The literature indicates that environmental quality, at least in some sectors, will increase with increased economic growth. Grossman and Krueger (1995) investigated the relationship between environmental quality and economic growth and whether increased economic growth led to greater levels of environmental damage. Grossman and Krueger's findings do not support this but indicate an initial drop in environmental quality at low incomes, showing improvement at higher levels of economic growth, with this change occurring before a country reaches $8,000 per capita income (approximately $11,400 in 2010 U.S. dollars). If one assumes that a greater interest in environmental quality increases with greater economic well-being and a higher

standard of living, then, as the Human Development Index goes up, you would expect greater compliance with the environmental commitments such as the Basel Convention. One possible explanation for the lack of statistical significance might be that there may be other economic factors, for example, GDP or the size of the industrial sector, which may be the driving force, rather than the quality of life and education factors included in the Human Development Index. Further investigation of additional variables that describe level of development is warranted to fully understand the influence of this independent variable on the dependent variable.

Citizens, both individually and in groups such as nongovernmental organizations (NGOs), in a democracy can have influence and input into how a government addresses issues, and this influence may be both proenvironmental as well as probusiness. On the international level, NGOs representing citizen and business interests were instrumental in the development of the Basel Convention and, on the national level, are currently active in tracking and publicizing compliance with this treaty. Wapner (2000) shows how NGOs can change state behavior, influence economic change, and bring about cultural change through instilling an environmental sensitivity among the citizens. The statistical analysis conducted during this research, using a number of NGOs per country per capita as a relative measure of potential citizen influence, did not indicate responsiveness to citizen input to be a statistically significant predictor. This is an unexpected result, as NGOs are at the core of collective action and have been influential in guiding national

and international environmental policy making relating to the Basel Convention for decades.

NGOs are difficult to study because of their diversity of purpose, various modes of operation, the ways they access funding, and cultural context in which these organizations operate (Lewis and Opuku-Mensah, 2006). International NGOs may operate differently than a local, indigenous NGO, and an NGO in Africa may operate differently than an NGO in North America. The breath of NGO diversity is indicated by Spar and Dail (2002), who suggest an NGO typology that includes 45 subtopic areas, one of which is pollution abatement. Possibly the independent variable selected to represent tolerance to civil society during this research, the total number of NGOs per country per capita does not represent the influence of the environmental NGO sector. Further work is needed to investigate the role of NGOs in promoting compliance with the Basel Convention, and a qualitative approach, as proposed in Section 9.3.1, may be a more appropriate approach to more fully understand the workings of specific NGOs.

8.6 Qualitative Needs Assessment of the Practitioners

The needs assessment data produced information on more short-term needs of the government officials responsible for ensuring compliance with the Basel Convention. Although priorities may differ, certain themes emerge that are common to both the Asian and West African regions. Both regions called for more clarity regarding the definition

of what constitutes a hazardous waste. The confusion caused by the lack of a common definition has also been highlighted at other meetings of national Basel Convention authorities, and this leads to difficulty in properly classifying a waste shipment upon arrival at a port. The development of documentation, either as training materials or visual aids, that explained the process of determining what is a waste and what is not a waste, along with real-world examples, would be a useful tool for officials.

Increased collaboration among national agencies responsible for import and export controls as well as with international partners, including the Secretariat of the Basel Convention, regional networks, and global networks, is needed to address this transboundary issue collectively. If ports act alone, the benefit of shared information and intelligence on modes of operation, preferred trade routes, and identities of those responsible for the illegal waste trade is lost. Working alone, port officials also miss the opportunity to leverage their resources with neighboring countries. Informal communications can be very effective in the exchange of information but relies on having access to updated national and regional contact lists, which were requested by respondents in both regions. An important role of enforcement networks, such as the Asian Network for the Prevention of Illegal Transboundary Movement of Hazardous Wastes, the International Network for Environmental Compliance and Enforcement, the Seaport Environmental Security Network, and the European Network for the Implementation and Enforcement of Environmental Law - Transfrontier Shipment of Waste, is to foster development of informal communications between port authorities.

8.6.1 Collective Action Considerations

This communication and collaboration, or cross fertilization as Ostrom (2005) refers to it, is difficult to achieve but can lead to innovative problem solving. Do individuals know one another, do they trust one another, do they feel the other person will act cooperatively when a situation arises, do they communicate, do they have accurate information (Ostrom, 2010)? These are some of the issues that need to be considered when evaluating a collective action. The personal relationships, i.e., the informal network, has a positive effect on the amount of information exchanged and can help dissolve the cultural and language barriers. However, if a subset of the involved entities do not participate in the collective action, the communications are less likely to be effective. Hence lies the problem in trying to get 175 entities to participate fully, as required by the Basel Convention. This is where regional networks may be especially effective. Ostrom's (1990) key collective action concepts revolve around cooperation, not competition. Dealing on the regional level, cultural context may still differ but may also be minimized compared to a global involvement. Countries in the same geographic region, such as South East Asia or West Africa, may share cultural, historical, economic, and political commonalities, and they also have a bigger stake in communicating with a neighboring country because there are transboundary environmental effects to be considered.

Ostrom (2005) acknowledges that it is more difficult to predict an outcome when looking at a collective action from the operational level. If the solution chosen is new and unfamiliar, and there is no history to rely on, the prediction of an outcome is especially challenging. Understanding how the new rules are viewed, understood, monitored, and enforced are important in explaining institutional change.

Ostrom (1990) warns that, because of the complexity of environmental issues, overarching governmental control, as espoused by Olson and Hardin to stop free riding in collective actions, is not the answer to preserving the commons. Instead, Ostrom advocates making decisions as close to the scene of the events as possible, with the decision tailored to fit the diversity of those involved. There is no one approach to solving a collective action issue. Experimentation may be required before a workable method of dealing with all the involved entities is developed. This is why INECE allowed each country to approach its inspection month activities in ways that suited its specific circumstances, with some countries using more sophisticated techniques than others.

Ostrom (2004) states that the empirical data do not support a top-down approach, but a bottom-up approach. Top-down approaches have to be more simplistic and generalized in order to appeal to a wide array of involved parties. For example, the Basel Convention is a product of intense negotiation and compromise, which was necessary to get the requisite number of ratifying parties needed to put it into force. The Convention

establishes broad overarching requirements for tracking transboundary shipments but leaves the implementation up to the individual countries. One can view multiple levels of collective action. Countries need to cooperate and communicate with each other to share information with the Basel Convention, which is a more formal process. There is a more informal, operational level where individuals communicate with regional colleagues. A level of trust, commitment, and knowledge is required for this to occur successfully. These operational-level activities do not need to be costly or involve expensive technology. These activities are developed to be adaptive to changing conditions over time and to meet the specific set of conditions of the operational system. Sometimes the actual initiation of these communications is the difficult part, so it may be prudent to start slowly, for example, with e-mail notifications of shipment-related information. As these communications become more routine, higher levels of communications can be attempted. The study of these self-organized operational-level governances, which incorporate user input, may shed light on how to generate useable information, how to identify and mitigate risk, how to resolve conflicts, and how to provide support to the national-level collective action efforts. These multiple levels may be nested within one another, as Ostrom (1990) suggests, but there needs to be an interaction between the organizational level and the national government level. This interaction provides support to the organizational level in terms of regulations, enforcement, and infrastructure, which is not available at the organizational level. In the case of hazardous waste management, there can also be a significant donor influence. For example, in the case of Ghana, which receives illegal shipments of hazardous waste, numerous donors including international

organizations and NGOs are conducting programs to increase inspection and enforcement capacity. Just installing technologically sophisticated equipment at the ports is not always the optimum approach; there needs to be a sustainable growth in capability of the actual practitioners.

It is interesting to note that the practitioners surveyed did not ask for advanced technologies. They asked for more communication and more collaboration, within their own countries and with neighboring countries.

One important concept of this collective action is the formation of regional networks. Both West Africa and Asian survey respondents requested more communication and collaboration with their regional neighbors and more face-to-face time with their counterparts in other countries through network meetings. These in-person interactions lead to the informal organizational networks. In reality, these informal regional networks meet the definition of Elinor Ostrom's "complex adaptive systems" as "composed of a large number of active elements whose rich patterns of interaction produce emergent properties that are not easy to predict by analyzing separate parts of the system. One can see them as consisting of rules and interacting agents that adapt by changing the rules dynamically on the basis of experience" (Ostrom & Ostrom, 2003, p. 12). These adaptive regional networks may be better suited to reacting to changing modi operandi of the illegal waste traders than a more rigid centralized system. Another benefit is that each of the units (countries) of the regional networks has the ability to learn from one another.

Countries with more advanced hazardous waste programs can help other countries develop their programs. Even countries with similar capacities can benefit from exchange of experiences and be able to support each other in time of crisis. Stern, Dietz, and Ostrom (2002) evaluated these challenges in relation to Ostrom's collective action design principles described in Section 3.8.3 and offer the conclusion that, if Ostrom's design principles are considered up front as general advice, the collective action will have an increased chance of success.

More enforcement capacity is needed at the ports, particularly in areas of understanding waste-shipment legislation, risk and threat assessments, cargo-inspection techniques, and interagency collaboration agreements. The concept of inspector exchanges is one method to accomplish this knowledge upgrade. During these exchanges, an inspector from a less developed country is trained at a port with more advanced capabilities. The inspector takes this knowledge home and incorporates it into his/her agency's inspection procedures. On-site training is an option and, like the inspector exchanges, is more individualized and therefore more costly. Regional workshops can offer specialized training to attendees. Online training has the potential to reach the maximum number of customs and port officials, who can take courses at a time and place that will not adversely impact their time "on the line". These online training modules can be designed to be adapted to a country's specific needs and translated at minimal cost.

Collectively working together to monitor transboundary shipments of hazardous waste can be an effective way to increase a port's ability to monitor compliance and enhance enforcement capability through consistent implementation of environmental laws and regulations. Through personal experience, a number of instances where bilateral communications allowed the interception of potentially illegal containers to occur have been observed. The use of informal networks, like the Seaport Environmental Security Network, may bring together people of both similar and diverse interests, facilitating action and building social capital (Dekker & Uslaner, 2001; Adler & Kwon, 2002). As communication changes, so may the outcome. Participants in the collective action are far more likely to be better informed of the consequences of their actions if they communicate with other participants. Face-to-face communication increases efficiency of a collective action (Ostrom, 2005).

Chapter 9: Conclusions and Recommendations

9.1 Two Approaches to Compliance with the Basel Convention

There are two ways to look at the issue of transboundary hazardous waste shipment. One is to address the immediacy of the concern; illegal hazardous waste shipments are arriving at ports every day, and government officials and inspectors need the tools to address these wastes now. The results of the International Network of Environmental Compliance and Enforcement (INECE) survey of Asian and West African waste management officials specifically identify these needs. Stronger regulations, a harmonized definition of hazardous waste, capacity for more effective enforcement, exchange of information and knowledge, and most importantly increased communication and collaboration on a national, regional, and international scale are top priorities for receiving countries.

A long-term solution is also needed, one that will reduce the flow of hazardous waste and deter the illegal hazardous waste trade. The waste needs to be stopped from ever entering the waste trade, and this can be accomplished through waste minimization and adequate in-country waste-management facilities. In order to accomplish this, a country needs to

have an effective hazardous waste program, including the implementation of legislation with rules and regulations, an agency to implement and enforce these regulations, an effective enforcement and compliance program, and in-country treatment and disposal capability (Probst & Beirle, 1999). The statistical analysis confirms this long-term need for support of research and development (R&D).

It is interesting to look at the hazardous waste export decision-making process through a collective action framework because protection of the environment requires a collective response. With a variety of actors involved, including government and nongovernmental organizations (NGOs), industry and individuals, collective action theory may offer workable processes for ensuring the protection of a resource for all through the actions of many. Working with officials responsible for the management of transboundary hazardous waste shipments indicates that this issue is a collective action issue. These officials stated the need for implementing legislation at the national level to enable them to take enforcement activity at the ports of entry. The government plays the key role in developing these import/export policies; however NGOs, such as the Basel Action Network, have been successful in producing an induced policy response by keeping the spotlight on noncompliant government activities.

Scale is an important consideration in evaluating whether collective action can be an effective tool in achieving greater compliance with international conventions. Although originally envisioned on the multi-individual or community level, the concept can be

scaled up to address complex environmental issues on a national, regional, and international level. Because of the importance of the national governing body in the decision-making process, this research focused at that level. When actual enforcement officials were surveyed, they also expressed a need for this national-level collective action; however they stressed a strong need to expand the scale to a regional level. Their experiences have shown that just developing an effective national program to manage transboundary shipments of hazardous waste is not sufficient, as the illegal shippers will seek out ports with weaker enforcement capabilities. This practice is seen in West Africa and Asia, where the illegal wastes are brought into ports with little or no regulatory and enforcement capability. Collaborating and communicating among countries in a geographic region was recognized by the practitioners as an effective way to collectively address the issue. This concept is embodied in the regional network that has recently been initiated in Asia and is being contemplated for West Africa. The formation of these networks has received wide support from both the governmental and nongovernmental entities dealing with the transboundary hazardous waste shipments.

Stopping these shipments at the receiving port is addressing the problem at the last possible point before hazardous materials are potentially released to the environment. The developing countries are the least prepared to be the last line of defense against hazardous waste. Therefore, the waste needs to be addressed before it enters international trade. The hazardous waste literature (Clapp, 1994; European Environment Agency, 2009; Fan, Chang, Ni, & Lee, 2005; Hsing, Wang, Chiang, & Fang, 2004;

Krueger, 1998; Montgomery, 1995; OECD, 1985; O'Neill, 1998; Singh & Lakhan, 1989) identifies a number of reasons why a country would export its waste rather than manage it within its borders, as mandated by the Basel Convention. The high cost of in-country treatment and disposal or a lack of treatment options are two of the reasons identified, with participation in international trade facilitating the export of this waste. For example, since the European Union (EU) instituted its open-border policy, it has seen a significant increase in cross-border hazardous waste shipments, indicating that the waste trade has become part of the larger regional trade (European Environment Agency, 2009).

When considering social, economic, political, and technological predictors, it was the technology variable that was statistically significant, leading to the conclusion that adequate technology is important in achieving compliance with the Basel Convention. This makes sense when you consider how embedded technology is in the minimization and environmentally sound management of waste. However, classical collective action literature (Hardin, 1968; Olson, 1965; Ostrom, 1990) focuses more on human behavior than on the importance of technology although Ostrom (1990) does state that the available technology is one factor to be considered when examining the structure of a particular collective action problem.

9.2 Policy Options Based on Quantitative Analysis

On the basis of the quantitative results of this research, there are policy options that could facilitate compliance with the Basel Convention, as measured by a lower percentage of hazardous waste shipments. These policy options focus on technology development support, which was indicated as a predictor of a lower percentage of hazardous waste exports. The policy recommendations are listed in order of broadness of scope, with the most overarching recommendations being listed first.

- ***Increase support to R&D, including environmental technologies***: The EU is looking to do just this as it attempts to increase its overall R&D commitment to 3% of its combined gross domestic product (GDP) (OECD, 2009). In 2009, President Obama echoed this goal when he stated that the United States would strive to devote 3% of its GDP to R&D (Sargent, 2010). This is an ambitious goal even for developed countries and one that will require a commitment to increased public and private funding in most countries. An increase in funding will spark the R&D sector, resulting in new and/or innovative waste-management technologies being brought online. Allocation of a portion of this money to environmental research is necessary; for example, in the United States, less than 0.5% of the total R&D budget for 2010 was set aside for research by the Environmental Protection Agency (Sargent, 2010). A commitment to increased R&D needs to have adequate funding earmarked for environmental research,

particularly that relating to waste disposal and treatment, in order to support the development of in-country waste-management capability.

- ***Development of waste-management treatment and disposal facilities***: Bromm (1990) lists six components of a successful waste-management program:
    - "political will and governmental infrastructure;
    - personnel trained in the technical, legal, and policy aspects of hazardous waste management;
    - adequate data to provide an understanding of the country's industrial processes, waste generation, and current waste management practices;
    - legislation adapted to the needs of the country;
    - a framework or strategy for management; and
    - development of waste management capacity" (p. 328).

These components track well with Probst and Beirle's (1999) major stages of waste-management program development, which also highlight the need for a mature compliance and enforcement program. The sequence in which these components are accomplished is not important and depends on the cultural, political, economic, and legal situation in each country. However, the actual siting of waste-management facilities will rely on many of these components to be successful. The development of a waste-management program will require long-term political commitment to sustain the process that can take 10–15 years to be

fully operational (Probst & Beirle, 1999). For countries with more developed waste-management programs, it may be a matter of developing technologies to meet the needs of their specific waste treatment and disposal needs, through government-funded initiatives or through support from the private sector. Technology development can be encouraged with an appropriate financing plan, including public, private, or a public-private funding partnership, and incentives, such as direct funding, tax breaks, and subsidies. Strong enforcement and compliance take some of the uncertainty out of the decision to develop one of these sites, as all generators would be required to meet the same regulatory requirements. Otherwise, the technology development may not be market driven and difficult to sustain financially.

- ***Countries should consider supporting the development of technology alliances, where the cost of innovative technologies development and use is shared***: Cooperative research networks can spur the development of technologies among firms that may later compete with each other. These networks can occur among private firms working together as a team to develop and market a technology or a public-private partnership, such as the Cooperative Research and Development Agreements that encourages the privatization of government technologies. Cooperative industrial alliances can be configured in a number of ways, including precompetitive alliances, where the conditions are developed for competition in the market; joint-value creation alliances, where the members compete as a team

in the market to provide a better service; competitive alliances, where a service or a technology is developed and provided to firms that compete against each other; and value-chain alliances, where transaction costs between buyers and suppliers are reduced as a result of the adoption of more efficient operations by all (Monge et al., 1998). Which configuration works best will depend on the specifics of the partners and will have to be customized on the basis of economic, social, political, and technological needs. Geography will also play a role, as it is desirable to minimize the distance the waste needs to be transported. For example, the cross-boundary development of expensive waste-management technologies that may only have a small piece of the market may allow the economy of scale to enhance profitability. Collective action can be effective in reducing the cost of development and access to waste-management technologies; however it can also be the cause of difficulties in siting the same facilities, due to public opposition.

- ***Enhanced-technology transfer programs****:* Collaboration through consortiums of academic institutions or industry organizations can encourage R&D to allow disposition of hazardous waste as close to the point of generation as possible. Technology exchange programs subsidized by the government, as in the inspector exchange programs requested by the government practitioners in the Asian region, can be effective in building enforcement capacity in developing countries. The sharing of experiences generated through these exchanges is beneficial to

identifying strategic solutions that can be applied through new policies, plans, and procedures at the national as well as regional levels.

This quantitative research confirms that support of R&D, which can translate into development of waste-management technologies, is the key predictor of a reduction in hazardous waste exports. Addressing this technology development collectively allows one country to leverage its knowledge, experiences, and resources with other countries striving to achieve the same ultimate goal, protection of human health and the environment.

9.3 Policy Options Based on Qualitative Needs Assessment

The results of the qualitative needs assessment indicate the more immediate needs of those officials responsible for the legal and illegal hazardous waste trades. Understanding the "view from the port" goes a long way to developing the right enforcement tools that are capable of providing the greatest impact. The results indicate that similar constraints to implementation of the Basel Convention exist in both West Africa and Asia. The policy options discussed in Section 9.2, relating to increasing in-country capacity to manage waste, are expected to reduce the number of transboundary shipments. Depending on how mature a country's waste-management program is, implementation of these options may take a decade or more to fully implement according to Probst and Beierle (1999). The policy options below address actions that can be taken

in the near term to provide immediate assistance in enhancing communication and collaboration, while building capacity.

- ***Consistent definition of hazardous waste***: Representatives from the West Africa and Asia regions called for more clarity regarding the definition of what constitutes a hazardous waste. The confusion caused by the lack of a common definition, especially in relation to what constitutes a second-hand good vs. a waste, has been highlighted at meetings of the Asian Network and the Seaport Environmental Security Network (SESN), and it leads to difficulty in properly classifying a waste shipment upon arrival at the port. The development of documentation, either as training materials or visual aids, that explains the process of determining what is a waste and what is not a waste, along with real-world examples, would be a useful tool for officials at the port. When the Basel Convention was put into force in 1992, electronic waste was not an issue and defining the hazardous characteristics of this waste was not considered in the waste identification scheme of the convention. Updating the Basel Convention waste-classification scheme to specifically address the hazardous components of electronic waste would help countries to incorporate this consistent definition of this material in national implementation of legislation.

- ***Increased collaboration***: Working together with national, bilateral, regional, and international partners who share responsibility for hazardous waste management

at ports of entry is needed to disrupt and deter the illegal waste trade. If ports act alone, the benefit of shared information and intelligence on modes of operation, preferred trade routes, and identities of those responsible for illegal shipments are lost. There are a number of ways to encourage increased collaboration, including but not limited to conducting joint cross-border enforcement operations, negotiating interministerial agreements to establish a formal protocol for environmental collaboration among national agencies, and sharing shipment-level enforcement-related intelligence with other countries.

- ***Increased communications***: The exchange of information can be very effective in increasing enforcement capacity, but it requires access to updated national and regional contact lists. Access to these lists was requested by respondents in Asia and West Africa. An important role of the regional and global enforcement networks, such as the Asian Network and the SESN, is to foster development of informal communications between port authorities. Effective communication is difficult to achieve but can lead to innovative problem solving, providing that individuals know one another and build a level of mutual trust, are able to communicate with one another, and believe the other person will act cooperatively when a situation arises (Ostrom, 2010). The personal relationships, established through informal networks, will have a positive effect on the amount of information exchanged and can help dissolve any barriers to effective cross-border collective action. However, if some of the involved entities do not

participate in the network, the collective action is likely to be less effective and could allow for weak links in regional enforcement to exist, which might be exploited by unscrupulous waste shippers. This is where inclusive regional networks, which foster cooperation, not competition, may be especially effective.

- ***Build enforcement capacity***: Increased knowledge in waste shipment legislation, risk and threat assessments, cargo inspection techniques, and interagency collaboration agreements was requested by practitioners at the ports. Training to advance this knowledge can be developed in a number of formats. Conducting inspector exchanges is a highly individualized, effective means of training port inspectors. Because of the intensive one-on-one focus of this training, it is costly. On-site training at the ports is an option but, like the inspector exchanges, is more individualized and therefore more costly. Regional workshops can offer specialized training to attendees. Conducting train-the-trainer programs may be an effective way to increase sustainability of on-site inspector training, as turnover of personnel at the ports equates to loss of knowledge, which will need to be replaced by additional training. Online training is a method to reach the maximum number of customs and port officials, who can take courses at a time and place that will not adversely impact their job responsibilities. Online training modules can be designed to be customizable to a country's specific needs and can be translated at minimal cost. Learning, combined with interaction, will lead to a greater ability to identify, interdict, and deter the illegal waste trade, while

allowing management of the legal waste trade in an environmentally sound manner.

- ***Establishment and maintenance of regional networks***: In order for geographic regions such as Asia and West Africa to collaboratively design strategies to overcome enforcement constraints in their respective countries, the officials need information, a forum where they can discuss this information and develop strategies, and the ability to initiate implementation of monitoring (port inspections) and sanctions (legal action), two components of enforcement and successful collective action (Ostrom, 2010). The initiation and maintenance of global and regional networks, suggested by the survey respondents, can provide these forums and facilitate the communication and collaborative relationships that lead to effective seaport environmental security.

- ***Develop partnerships with the waste-shipping industry*:** As hazardous waste exports continue to rise, the shipping industry will become more involved in the waste trade, and this presents certain risks to personnel, equipment, and business. If an illegal container is detected, the entire ship may be delayed, disrupting business and incurring costs. There are a number of reasons the shipping industry should take a more active role in preventing illegal shipments.

- Preservation of its company business reputation and ability to be considered a trusted shipper
- Concern over the safety of its crew and ship if unknown dangerous and toxic hazardous wastes are aboard. Special regulations must be followed for the proper stowing of hazardous cargo.
- Financial and legal concerns, relating to delays, fines, and legal actions

Shipping companies can play an important role in identifying and deterring the illegal trade in hazardous waste as a result of specific knowledge of waste brokers, importers, exporters, and freight forwarders. The sharing of this information with government entities can augment enforcement efforts and help disrupt the illegal waste trade. Currently, the responsibility for a returned container usually lies with the exporter, not the shipper. A recent incident in Nigeria provides an example of the liability the shipping industry might incur by transporting illegal waste, even if the shipper is unaware of the waste's presence. In October 2010, the National Environmental Standards and Environmental Regulations Agency (NESREA), the Nigerian environmental ministry, intercepted an illegal shipment of electronic waste at the Port of Lagos, Nigeria (allAfrica.com, 2010). The ship, the *Vera D*, was held in the Port of Lagos while the incident was investigated and the captain was detained. Besides the costs incurred by the shipping company, this is one of the first instances where the ship captain was held responsible for the misrepresentation of cargo on his ship. In order to avoid this liability in the future, shipping companies may see the benefit of a cooperative partnership with

enforcement agencies, which will in turn allow the enforcers to have better intelligence on the illegal waste traders.

9.4 Areas for Future Work

The analyses conducted in this study provided some answers about what factors may predict whether a country will export its waste or manage it in-country and what might aid the implementation of the Basel Convention. The research also produced some unexpected results, which will require further research to fully understand. Approaches for future research are presented below.

9.4.1 Examination of Role of NGOs

How can the role of NGOs be investigated qualitatively in relation to the level of influence these organizations might have in the national decision-making process?

The siting of hazardous waste-management facilities, whether for treatment or disposal, can evoke strong oppositional response from the public. This can be manifested in difficulty in siting and developing these facilities, as manifested in the not-in-my-back-yard situation, or NIMBY. It may not be the technology itself that is being opposed but

the social context in which it is presented (Winner, 1985). NGOs can play a major role in instigating and maintaining this opposition.

During the past three decades, there has been an increase in NGOs, especially in the developing countries. NGOs provide a number of functions, such as influencing negotiations, representing certain sectors of civil society, providing innovation and creative ideas in implementing programs and international agreements, and being the watchdog of corporations and governments. The focus of the NGOs may be to represent the civil majority, an industrial or commercial viewpoint, or a small marginal viewpoint. The relationship of NGOs with governments may be collaborative or confrontational; NGOs may be facilitators or stumbling blocks to policy change.

The statistical analysis conducted in this research did not indicate that the number of NGOs operating in a country is significant in predicting whether a country will decide to export hazardous waste. It may be that the total number of NGOs does not predict the level of influence these organizations have on government decision-making processes. On the basis of the diversity of NGOs, as mentioned by Lewis and Opoku-Mensah (2006), it may be more appropriate to study NGOs in a qualitative manner, in order to get the level of specificity necessary to fully understand the influence of NGOs. Lewis (2005) criticized the early study of NGOs for focusing on organizational and technical issues and not on the context of the environment in which these organizations operate. Igoe and Kelsall (2005) posit, “rather than assume that NGOs have universally intrinsic

qualities, it is more fruitful to assume that they will reflect the socio-historical conditions of the locale in which they operate" (p. 8). Therefore, cross-national quantitative analysis may not reveal this contextual information that is so important in understanding the power of the NGO. There is also the aspect of the evolution of NGOs as a country's level of development increases, governmental institutions mature, freedom of the press is institutionalized, and the focus of the issue itself changes. As policy changes, the role of NGOs may change to maintain their relevancy, and this needs to be considered in any analysis of these organizations. This requires a closer study of individual NGOs than can be determined by more generalized statistical analysis alone.

A comparative case-study approach is an appropriate method for understanding the capability of NGOs to influence governmental entities. The case studies should examine how organizations are structured and function but also focus on the political environment in which the NGOs operate. Besides interviews, information can be obtained through the use of surveys, which will serve to standardize the specific information collected. Role-playing exercises with individual NGOs might produce interesting insight into how the thought process of the organization functions. Role-playing can help determine how that particular NGO approaches a specific scenario and how the organization might mobilize to address the issue and exert their influence. The use of these qualitative methodologies will help determine what each NGO is capable of accomplishing and what constraints exist.

In planning a study on NGOs, it would be interesting to consider the following aspects.

- *NGO legitimacy and NGO access*: Martens (2006) lists these two factors as important when considering NGOs that operate at the international level, such as the Basel Action Network. Legitimacy refers to NGO accountability, clientele representation, and internal organization. NGO access refers to the international forums the organization has access to, taking into account the process that grants the organization access.
- *Historical, political, and theoretical context in which the NGO operates*: A conceptual reframing of how NGOs are analyzed, emphasizing how the NGO is embedded in the institutional system in which it operates, or the contextual framework should be evaluated (Igoe & Kelsall, 2005; Lewis & Opoku-Mensah, 2006).
- *Source of funding*: The NGO's source of funding may influence, not only the extent of activities, but also the direction of these activities. The source of donor support may make a NGO appear to be an agent of a specific interest, either foreign or domestic, which may be reflected in the way the government perceives and interacts with the organization (Spiro, 2002).
- *Accountability*: Whether or not the leadership is elected by members or how any dues and donor contributions can be used will help determine the level of discretion the leadership has to represent the membership (Spiro, 2002).
- *Interaction with other organizations*: To be effective the NGO will need to interact with various other organizations, including governmental, industrial, and

civil entities. Wapner (2002) points out that there may be only minimal internal checks and balances governing the NGO's behavior because the leadership and the members are all of the same ideology. Because the NGO can initiate political activity, how these organizations coordinate or collaborate with other organizations is important in achieving success.

9.4.2 Examination of Cross-Boundary Compliance and Enforcement in Other Sectors

Are there other sectors that have dealt with the difficulty of ensuring cross-boundary compliance and enforcement, and can these sectors be used as examples to better understand how to approach this issue in relation to the Basel Convention?

The Basel Convention is not alone when discussing implementation difficulties. Any international convention that does not have enforcement authority will be unable to compel countries to meet stated commitments. The other two international conventions relating to hazardous materials management, the Rotterdam Convention and the Stockholm Convention, face the same issue of nonbinding standards. National implementation is required, and it is the responsibility of the individual country to put into force implementing legislation that will promote compliance and allow government enforcement. As a result, the actual level of implementation varies widely among nations

because of the differences in the political, economic, and social systems. As a result of this complexity, a "one size fits all" regulatory program will not lead to effective implementation.

The difficulty with achieving effective global implementation has been noted in other industries, such as the international commercial air transportation. Button, Clarke, Palubinskas, Stough, and Thibault (2004) discuss the issues created by the voluntary compliance mechanism of the International Civil Aviation Organization (ICAO), which sets out safety measures for international air travel. Individual governments are responsible for monitoring and setting standards for aviation safety and security, with ICAO having no legal authority for imposing penalties on noncompliers. During the Fifth International Summit on Aviation Safety and Security, held March 3-7, 2003 in Washington, DC (R. Stough, personal communication, April 1, 2011), the participants agreed that the following actions are necessary to have effective compliance with ICAO standards:

- compliance with standards;
- cooperation among Member States, particularly on a regional basis, to ensure continuing compliance;
- continuing communications to discuss regional cooperation and compliance initiatives;

- ongoing financial, regulatory and technical assistance in some Member States to properly establish the bases for compliance with Standards; and
- continuing commitment to national and regional initiatives.

These actions mirror what is necessary to successfully implement the Basel Convention, as determined by the qualitative assessment of practitioners. There are several solutions identified by the officials responsible for air safety that may be applicable to the Basel Convention (ICAO, 2004; Lindsay, 2005). An examination of how the aviation safety industry approaches these potential solutions could shed light on ways to increase implementation of the Basel Convention.

- *Implementing legislation*: This legislation may not be in place when a country ratifies an international convention or agreement. The use of model legislation, developed by the international entity, complemented with a review of existing country legislation is a good place to start the legislative process. Each country adapts the model legislation to meet specific political and economic constraints, and possibly cultural influences. Political will to implement a sustained legislative program is necessary.

- *Compliance and enforcement capability*: Even if legislation is in place, unless it is implemented and enforced it will not be effective. Some countries require assistance in building this capacity through training, financial assistance, and

access to appropriate inspection and analytical tools. ICAO approaches the task of bringing countries up to the same level of compliance and enforcement capability in two ways: (1) countries with more advanced regulatory oversight programs assist countries that are in the process of developing air safety programs, and (2) ICAO offers technical assistance and capacity development to countries that request it.

- *Regional cooperation*: Working together regionally to share information, expertise, and possible resources can be a more efficient way to expand global compliance than depending on the individual countries to develop and operate national programs. This is especially true in regions where there is considerable developmental and economic diversity. At an aviation safety meeting of the Pacific Island nations (R. Stough, personal communication, April 1, 2011), which depend on air transportation to support economic growth, the concept of regionalized cooperation was widely accepted. Whether or not these regional organizations or networks could be recognized as functioning regulatory bodies would be interesting to research, especially in the Pacific Island region, where there are a number of small island states with limited economies and resources but who require safe, economical aviation to thrive. The ability of the international organization to support any regional organizations should be examined.

- *Constraints to implementation of standards*: Budgetary constraints are ubiquitous impediments to compliance with international agreements. ICAO is looking at the identification of other constraints such as physical barriers, political organization, lack of personnel resources, inability to collect and maintain accurate records, and the lack of harmonized standards. Because these are the same constraints that impede full implementation of the Basel Convention, the manner in which ICAO addresses these constraints may be directly applicable to the Basel Convention.

A second sector that may provide insight into implementation of the Basel Convention is the management of radioactive waste. Radioactive waste is not covered under the Basel Convention but is managed through a parallel system overseen by the International Atomic Energy Agency (IAEA). For clarification, the IAEA defines radioactive waste as "any material that contains or is contaminated with radionuclides at concentrations or radioactive levels greater than the exempt quantities established by the competent authorities for which no use is foreseen" (IAEA, 1990). There are a number of similarities between the transboundary movement of hazardous waste and radioactive waste. An examination of the level of compliance with the IAEA standards may provide insight into how to increase compliance with the Basel Convention. The following characteristics of the IAEA program are some suggested areas for further consideration.

- *Definition of radioactive waste*: The IAEA developed a classification system to help clarify the definition of radioactive waste, placing the waste into three categories, including exempt, low- and intermediate-level, and high-level waste. This improves the clarity of information exchange between countries through harmonization of terminology and allows for improved cross-border communication (Strack, 2003). The need for a clear definition of "what is a hazardous waste and what is not" was requested by both West African and Asian survey participants polled during this research.

- *Need for technical assistance*: Compliance with international regulations regarding transboundary shipments of radioactive waste and hazardous waste encounters similar impediments, including the need for technical assistance to develop infrastructure to manage the waste in an environmentally sound manner. The location of limited radioactive waste-management facilities dictates that transboundary transportation of these wastes will be necessary to ensure proper management. Countries need to have regulations in place to control imports and exports of radioactive waste and prevent illegal shipments of radioactive waste and to have technical capacity and administrative procedures in place before receiving any radioactive wastes. Meeting these requirements may be difficult for developing countries, as it is for countries trying to implement the Basel Convention. Understanding how technical assistance from the IAEA is delivered to countries in need may be a model for technical assistance to parties of the Basel

Convention.

- *Cooperation at the bilateral, regional, and international levels*: Prior informed consent is required before any transboundary shipment can take place, giving each country the sovereign right to accept or reject any import or export of radioactive waste. Every country is required to take appropriate action to ensure that imported or exported radioactive waste is handled in accordance with international safety standards. In order to accomplish this, a mechanism for cooperation with other countries is required, as it is with the Basel Convention.

- *Use of a code vs. a convention:* A Code of Practice on the International Transboundary Movement of Radioactive Waste, rather than an international convention, was chosen as the mechanism for promoting international standards regarding movements of radioactive waste. This allowed rapid action to be taken by countries and allowed countries without national implementing legislation in place to participate. The IAEA use of voluntary codes of practices or conduct rather than conventions has proven to be effective for IAEA activities, even though these codes are not legally binding (Jankowitsch, 1990). This Code of Practice becomes part of a broader program of voluntary and legally binding standards, already in place, that control radioactive materials and wastes.

9.5 Summary

In conclusion, this research identified two different approaches to addressing the same issue. A long-term solution involving the development of in-country waste management programs, identified by the quantitative analysis, is very costly, involves complex technologies, and requires sustained political will to achieve. The short-term solutions, proposed by the individual practitioners, are relatively low cost, low technology, and are based on personal relationships. Using a mixed methodology to examine the issue of hazardous waste exports allowed the identification of both broad policy needs as well as individual actions that can be taken to enhance implementation of the Basel Convention. Numerous policy options exist for addressing the long-term and the short-term needs, each contributing to enhanced compliance with the Basel Convention through minimization of hazardous waste exports.

Appendix A

Appendix A

Examples of Illegal Hazardous Waste Shipments: 2000-2008
(Sources: various news services and government reports)

	Receiving Country	Country of Origin	Type of Waste	Amount of Waste	Comments	Reference
2009						
August	Brazil	United Kingdom	Medical clinic waste	89 containers	Hazardous waste mislabeled as recycled plastic; returned to UK	Guardian.co.uk. August 21, 2009
2008						
November	Nigeria	Ukraine	hazwaste	unknown	ship attemped to dock in Delta State, Nigeria	allAfrica.com, Nov 5,2008
June	Nigeria, Ghana		Chemically altered waste oil marketed as gasoline	unknown	Trafigura ship	*afrol News*, June 24, 2008
2007						
January	China	Britain	waste	unknown		*The Independent* (UK), January 26, 2007, Times On-line 11/06/06

2006						
August 11-22	Cote d'Ivoire	unknown—pickup off Gibraltar	"slops": petroleum, caustic soda, hydrogen sulfide, mercatans, etc.		Trafigura ship; killed 10, injured more than 30,000 people	*Sunday Herald*, UK, Oct 1, 2006
Throughout 2006	China	Britain	Plastic, paper, cardboard	220,000 ton plastic for recycling, 2.2 million tons used paper, cardboard		*The Independent* (UK), January 26, 2007
Throughout 2006	China	EU, US, Korea, Japan	Hazardous waste	49 cases of hazardous waste; 8,000 tons of solid waste		PRC General Administration of Customs, China
Shipments throughout 2006	Lagos, Nigeria	Western Europe, US	e-waste	500 containers per month		*Sunday Herald*, UK, Oct 1, 2006
2005						
Shipments throughout 2005	South Asia	Britain	e-waste	25,000 tons		*CSRWire*, Sept. 25, 2008

2004						
June	Malaysia	Taiwan	Industrial waste	200 shipping containers; total app. 13,200 tons	Used fake Malaysian import license; believed to be more containers of hazwaste in Malaysia	*Borneo Bulletin*, June 17, 2004
September	Turkey	Spain	Fly ash containing chromium VI	2,200 tons	Rejected by Algeria, ship went to Turkey, where it sank after 4 years at anchor	*Greenpeace News*, *Reuters South Africa*, July 12, 2007
December	Somalia	Italy, Switzer-land	radioactive, chemical, industrial, hospital waste, including lead, cadmium, mercury, flame retardants	unknown	Drums washed up during 2004 tsunami along 400 miles of Somali coastline	2008: UNEP stated there was evidence hazardous waste was disposed in Somalia

2003						
April	Thailand	UK and others	22 tons of e-waste, unspecified amounts of battery and medical wastes and 1,000 tires	22 + tons	Thai ports of Klong Toey in Bangkok and private port in Samut Prakan	*Asia Pulse*, April 1, 2003
October 2003 – March 2004	Domin-ican Republic	U.S. – Puerto Rico	Coal ash	82,000 tons	Left on beaches	*Associated Press*, March 16, 2006
2002			No data			
2001			No data			
2000						
September	The Gambia	unknown	"toxic waste"-laden vessel	unknown	Abandoned in the Gambian port of Banjul	*The Independent* (Banjul), Sept. 8, 2000
unknown	Senegal	unknown	"toxic-waste"-laden vessel	unknown	Sent away by Senegalese security	*The Independent* (Banjul), Sept. 8, 2000
July-November	Nether-lands, en route to Nigeria	United States – Pennsyl-vania	Flammable, corrosive and toxic chemicals	29 40-ft containers	Wastes from Pyramid Chemical Co. detained at Rotterdam for three years	US EPA http://servicetoamericamedals.org/SAM/recipients/profiles/jlm06_harrell.shtml
August	India	unspeci-fied Gulf countries	Hazardous waste oil	133 containers	Waste oil mislabeled as furnace oil	*The Indian Express*, June 25, 2006

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Curriculum Vitae

Deborah Ann Kopsick was born in Queens, New York and attended high school on Long Island, NY. She received her Bachelor of Arts degree in Geology with honors from the State University of New York (SUNY) at New Paltz in 1974. She worked for SUNY New Paltz prior to attending the University of Kansas, where in 1980 she was conferred a Master of Science degree in Geology with honors, with a specialization in environmental geochemistry. Ms. Kopsick worked for the Kansas Department of Health and Environment as a geologist from 1979 to 1980, investigating hazardous waste disposal sites. From 1980 to 1997, Ms. Kopsick worked for Ecology and Environment, Inc., an environmental consulting firm, where she was a senior level hydrogeologist in the Kansas City, KS office and Assistant Program Manager in the Washington, DC office. In the Washington office, Ms. Kopsick managed the technical operations of thirteen hazardous materials emergency response teams stationed throughout the U.S. In 1997, she joined the U.S. Environmental Protection Agency's Office of Air and Radiation in Washington, DC where she participated in the Agency's radiological emergency response center. She is currently working with EPA's Office of Enforcement and Compliance Assurance working on international issues relating to the import and export of hazardous waste. Ms. Kopsick is a Certified Professional Geologist.