**Boston University** The Frederick S. Pardee Center
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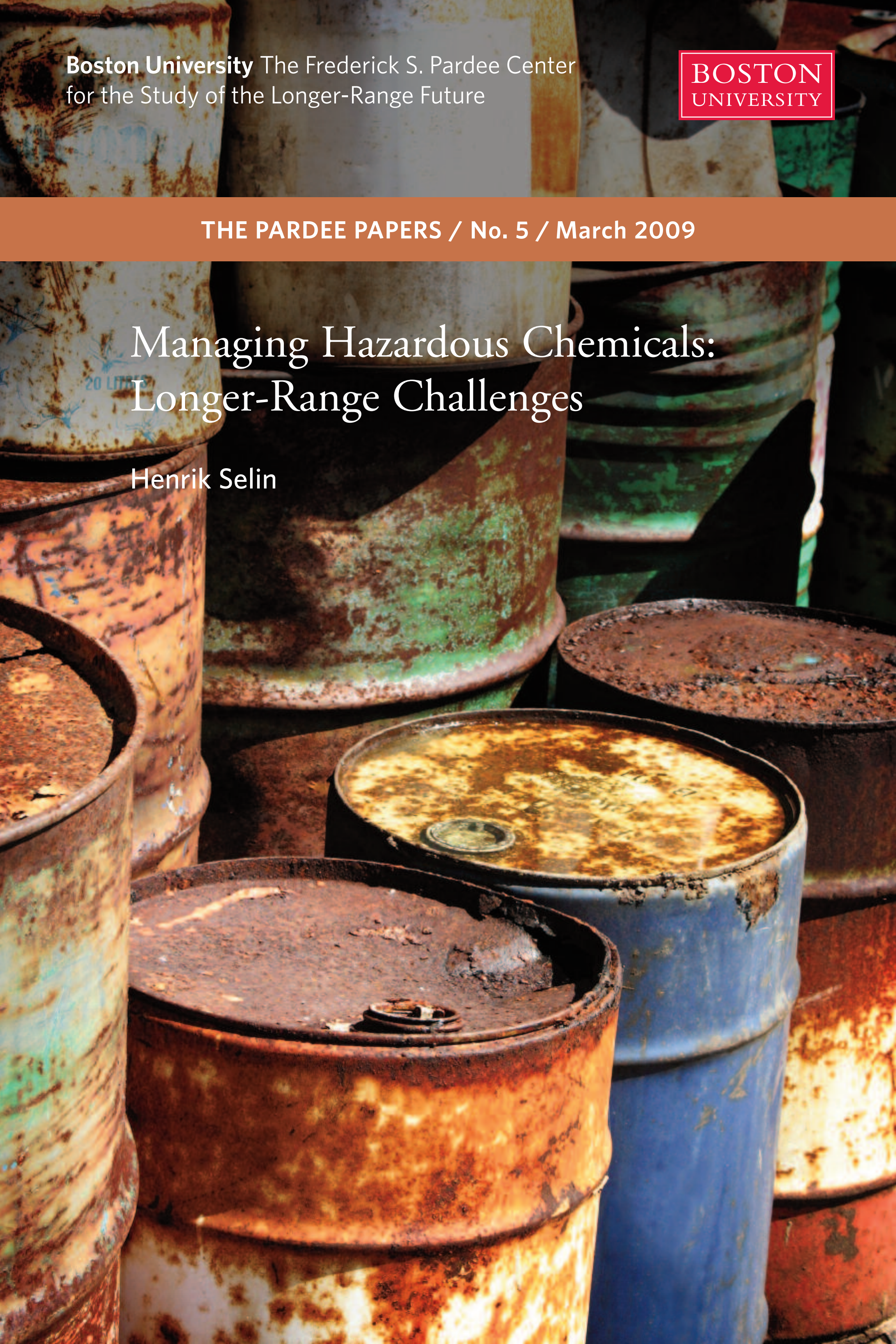
**THE PARDEE PAPERS / No. 5 / March 2009**

# Managing Hazardous Chemicals: Longer-Range Challenges

Henrik Selin



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# Managing Hazardous Chemicals: Longer-Range Challenges

Henrik Selin

***Abstract***

*Improving global chemicals management is a significant sustainable development issue, involving many longer-range challenges. This paper examines some of these challenges. It begins by describing hazardous chemicals as a longer-range problem. This is followed by an outline of the global policy framework for managing hazardous chemicals. Next, the paper discusses four sets of management challenges for better environmental and human health protection: 1) Enhancing ratification and implementation of existing regulations; 2) Expanding risk assessments and controls; 3) Improving management capacity and raising awareness; and 4) Minimizing generation of hazardous chemicals and wastes. Furthermore, the paper argues that the adoption of more proactive and precautionary policies and management approaches is ultimately needed to achieve necessary environmental and human health protection standards. While some such policy and regulatory changes are under way in the European Union and other regions, they are not yet sufficiently reflected in international law.*

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## INTRODUCTION

Most environmental and human health problems, as well as their solutions, must be approached from a longer-range perspective. This longer-range view certainly is necessary for chemicals management, which is a critical but somewhat overlooked sustainable development challenge for both industrial and developing countries. Hazardous chemicals are released through, for example, agricultural activities, industrial production, combustion processes, and leakages from waste streams. A comprehensive chemicals policy requires interrelated controls for each stage of the life cycle of pesticides and industrial chemicals, covering their production, use, trade, and disposal. Emissions of many by-products must also be regulated (Downie, Krueger, and Selin 2005). While some important progress in addressing problems of hazardous chemicals can be noted at the international level and in specific countries, a large number of chemicals still pose unacceptable environmental and human health risks around the globe.

Many people, particularly in developing countries, are exposed to a multitude of hazardous chemicals at their workplace or through use of common household products. In many cases, this is because of a lack of knowledge about chemical risks and/or a failure to take even basic protective measures. The severity of the situation can be illustrated by a few examples:

- A study of one hospital in the Indian state of Andhra Pradesh found that 8,000 patients were admitted with severe pesticide poisoning between 1997 and 2002. Over 1,800 of these patients died as a result of this exposure (Srinivas Rao et al. 2005, 582).

- The government of Tanzania (2005, 92) has noted that domestic facilities for safe storage, transportation, and disposal of many hazardous pesticides and industrial chemicals, including polychlorinated biphenyls (PCBs), are basically nonexistent.

- The Cambodian government stated in a 2006 national assessment report:

  "The exposed employees and workers who work in transformer workshops, warehouses, and power plants are unaware of PCBs hazard.

> For instance, they have pumped PCBs oil from container to transformer, and pumped used PCBs oil from one broken transformer to another by siphoning by mouth. In addition, employees and workers have often used PCBs oil to paint furniture and to sell to other people for various uses." (Royal Government of Cambodia 2006, 35).

It can be difficult to establish effective structures for environmental and human health protection. Public authorities must design and implement chemicals policy in the face of a host of scientific uncertainties. Many regulatory decisions must be made under conditions of scientific uncertainty due to incomplete assessment data about a chemical's environmental properties and the kind of health risks that it may pose throughout its life cycle. Chemicals management can require balancing sometimes conflicting political and economic interests. Policy makers and regulators must attempt to maintain a socially acceptable level of environmental and human health protection while not unnecessarily restricting benefits of modern chemistry. In fact, chemicals management presents public officials "with some of the most intractable dilemmas of social regulation" (Brickman, Jasanoff, and Ilgen 1985, 21).

Chemicals management can require balancing sometimes conflicting political and economic interests. Policy makers and regulators must attempt to maintain a socially acceptable level of environmental and human health protection while not unnecessarily restricting benefits of modern chemistry.

Hazardous chemicals management also touches upon significant environmental justice and equity issues between the global North and the global South (Pellow 2007; Iles 2004; Hough 2003). There is, for example, a very strong connection between the international trade in hazardous chemicals and wastes, and the risks that workers in developing countries are exposed to by using pesticides and/or being employed in the waste recovery business; many of these chemicals and wastes are shipped from industrialized countries as part of a longstanding globalization of trade. Developing countries also often lack adequate technical, financial, and/or human resources to initiate more effective risk-reduction measures. Thus, international political and technical activities addressing hazardous chemicals can function as catalysts for the diffusion of knowledge and resources that enable the creation of better domestic protection measures.

This paper examines longer-range management challenges posed by hazardous chemicals. The first section discusses important aspects of the chemicals problem, including extensive use of a multitude of hazardous chemicals, time lags in the detection of environmental damages, and lingering human health risks. This is followed by a presentation of the global policy framework for managing hazardous chemicals. Next, the paper discusses four sets of management challenges for better environmental and human health protection: 1) Enhancing ratification and implementation of existing regulations; 2) Expanding risk assessments and controls; 3) Improving management capacity and raising awareness; and 4) Minimizing generation of hazardous chemicals and wastes. The next section calls for the adoption of more precautionary management approaches. The paper ends with a discussion of the need for a more proactive, longer-range approach to chemicals management.

## HAZARDOUS CHEMICALS AS A LONGER-RANGE PROBLEM

The numerous products of the chemical industry play significant roles in national economies, particularly in industrialized and high-consumption societies. Tens of thousands of chemicals are regularly used to increase yields of major cash crops, to improve public health, and to produce countless consumer goods. Some chemicals are produced in volumes of millions of metric tons per year, but most are only produced in quantities of less than 1,000 metric tons annually (OECD 2001, 10). Global sales of chemicals grew almost nine-fold between 1970 and 2000. The Organisation for Economic Co-operation and Development (OECD) estimates that the global output of the chemicals industry will roughly double between 1995 and 2020 (OECD 2001, 16). Worldwide sales of chemicals were worth approximately $2 trillion in 2005 (CEFIC 2006, 2), close to 10 percent of all global trade (OECD 2001, 10).

Asia (mainly Japan, China, and India) is currently the world's leading chemicals-producing region in monetary terms, closely followed by the

European Union (EU) and the United States. It is likely that the industrialized countries that currently host the largest multinational chemical companies will continue to be the largest producers and per capita consumers of chemicals in 2020. However, the OECD (2001, 35–36) predicts that the rate of production and consumption over the next decade will grow much faster in the major developing countries that continue down a path of industrialization and agricultural modernization. Yet, many specialty and life science chemicals—whose production require advanced technology and educated workers—are expected to continue having higher growth rates in industrialized countries, while developing countries will experience most growth in the production of more low-technology, basic chemicals.

Many chemical risks are related to agriculture. The Green Revolution, initiated by the Rockefeller Foundation in the 1940s, helped develop new high-yield varieties of major cash crops including rice, wheat, and maize that, together with the design of better irrigation schemes and increased use of nitrogen fertilizers, increased food production (Linnér 2003). However, many of these new plant varieties were highly susceptible to diseases and pests, and therefore required large amounts of pesticides. The World Health Organization (WHO) estimated in 1990 that approximately three million people worldwide were hospitalized annually as a result of pesticide poisoning, resulting in 220,000 annual deaths (Jeyaratnam 1990, 140). More recent studies put annual fatality figures from exposure to toxic pesticides closer to 300,000, with 99 percent of these cases occurring in developing countries (Srinivas Rao et al. 2005, 581).

The WHO has worked to classify hazardous pesticides since 1975, publishing updated classification lists as a way to disseminate hazard information to national governments and stakeholder groups (WHO 2005). The WHO classification scheme of active ingredients in pesticides is based on acute toxicity data. It distinguishes between more or less hazardous forms of each commercial pesticide based on the toxicity of its technical compounds and formulations, dividing pesticides into several classes: Ia (Extremely Hazardous); Ib (Highly Hazardous); II (Moderately Hazardous); and III (Slightly Hazardous). The WHO also lists active ingredients unlikely to present acute hazard in normal use. There is a long list of observed effects of pesticides poisoning, including burning eyes, skin rashes, headache, dizziness, vomiting, loss of consciousness, and even death (Mancini et al. 2005).

Modern integrated pest management (IPM) practices have been developed since the 1950s to shift away from habitual use of hazardous pesticides. IPM is not a single pest-control method, but consists of a combination of multiple environmentally friendly approaches intended to significantly reduce and, where possible, eliminate the use of pesticides. IPM-related approaches include increased planting of pest-resistant crop varieties, the use of local beneficial insects for pest control, the design of more effective crop rotation schemes, and improved soil management. There is also a growing body of empirical evidence from many developing and industrialized countries across geographical regions that IPM strategies are both economically and environmentally desirable, contributing to sustainable development (Nwilene, Nwanze, and Youdeowei 2008; Mariyono 2008).

Many hazardous chemicals management issues are linked with expanding industrialization and growing consumption (Geiser 2001). There have been several high-profile cases of industrial accidents, including Yusho, Japan in 1968 (PCBs leaking from a faulty heat exchanger contaminating rice), and Bhopal, India in 1984 (a chemical factory accidentally releasing methyl isocyanate into the air killing thousands of people). Industrial processes also produce emissions of hazardous by-products such as dioxins and furans. In addition, hazardous chemicals leak from discarded goods and other kinds of wastes that are disposed of inappropriately. This includes rapidly growing levels of electronic wastes (e-wastes) containing a myriad of hazardous substances. As in the case with pesticides, many human health consequences—for example, increased cancer levels—from acute exposure to industrial chemicals and by-products linger for a long time.

Many hazardous chemicals are persistent and remain in the environment and human bodies for a long time. Scientific studies show that persistent organic pollutants (POPs), a category of particularly long-lived and toxic chemicals, may remain in the natural environment for decades.

Emissions of hazardous chemicals can travel long distances via air currents, waterways, and migratory animals (AMAP 2002). Long-range transport of emissions contributes to a gradual increase in concentrations and chronic exposure of toxic chemicals to animals and humans through bioaccumulation and biomagnification. Many hazardous chemicals are persistent and remain in the environment and human bodies for a long time. Scientific studies show that persistent organic pollutants (POPs), a category of particularly long-lived and toxic chemicals, may remain in the natural environment for decades (Rodan et al 1999). Environmental problems caused by hazardous chemicals must be viewed over decade-long time scales as they may bioaccumulate and biomagnify in living organisms for such time periods. See Box 1 for a brief summary of important characteristics of hazardous chemicals.

### Box 1: Important Characteristics of Hazardous Chemicals

**Persistence:** The more persistent a chemical is, the longer it remains in the environment before it biodegrades. Persistence can be measured in several ways, including half-life (i.e., the amount of time it takes for a chemical to decay to half its value) in air, soil, water, and sediment. The more persistent a chemical is, the longer its half-life. Persistence per se is not dangerous, but gives rise for concern if a chemical exhibits other undesirable qualities with respect to toxicity, bioaccumulation, and biomagnification.

**Toxicity:** A chemical's toxicity can be measured by focusing on chemical, biological, and physical entities. Toxicity refers to the effect a chemical may have on an organism or part of an organism (organ, tissue, or cell). Different organisms may exhibit different responses to the same dose of a toxic chemical. Common concerns about toxic chemicals include their ability to cause different kinds of cancer, act as endocrine disrupters, and negatively affect the early stages of human development.

**Bioaccumulation:** An essential biological process that takes place in all living organisms to obtain necessary nutrients. Problems can arise when hazardous substances that have been released into the environment are accumulated through the same mechanism as the nutrients, allowing them to build up in fatty tissues of organisms over time. Consequently, an older member of a species will normally have a higher body burden of hazardous chemicals than a younger member.

**Biomagnification:** A biological process related to bioaccumulation, as hazardous chemicals that have bioaccumulated in a large number of organisms at a lower trophic level are concentrated further by an organism at a higher trophic level as those chemical concentrations are passed up through food webs. As a result, species at the top of food webs (including humans) typically have higher concentrations of hazardous chemicals in their bodies than species lower down the same food web.

Environmental risks from exposure to hazardous chemicals include estrogenic effects, disruption of endocrine functions impairing the operation of immune systems, functional and physiological effects on reproduction capabilities, and reduced survival and growth of offspring (AMAP 2003). Continuing, low-dose exposure in humans has been linked to carcinogenic and tumorigenic effects as well as endocrine disruptions. As a result, societies must take a longer-term perspective on managing risks from long-term, low-dose exposure. Authorities in many countries recommend that pregnant women and small children limit their dietary intake of certain foods (mainly fish with a relatively high fat content) to limit exposure. Such recommendations cover not only relatively new chemicals such as several brominated flame retardants, but also many chemicals first regulated in the 1960s, such as DDT and PCBs, that are still commonly found in food products.

Since environmental concentrations of chemicals build up over a long time, the detection of many risks may take decades. For example, it is believed that an Austrian student originally synthesized DDT in the 1870s (Mellanby 1992). However, it was not until the late 1930s, when the Swiss chemical company Geigy decided to expand its activities in the rapidly growing market area of pest control, that DDT's pest controlling abilities were realized. Paul Müller was awarded the Nobel Prize for Medicine and Physiology for his discovery of DDT's pesticide properties in 1948, just a few years after it became commercially available. Following the publication of Rachel Carson's book *Silent Spring* in 1962 that highlighted the harmful effects of widespread application of DDT, most countries began slowly restricting DDT's use, eventually banning it completely. DDT is still used in a few tropical countries against malaria-carrying mosquitoes, as the international community continues to struggle to control malaria (Sachs 2002).

Similarly, PCBs were first synthesized in 1881 and were commercially produced by Monsanto beginning in 1929. PCB use had become widespread in a variety of products including transformers and oils by the 1970s (Koppe and Keys 2002), despite the fact that the first scientific warning about PCB-like substances had been made in 1899, when they were linked with the skin disease chloracne. In the mid-1960s, scientist Sören Jensen expressed concern over PCBs entering the air causing environmental contamination.

He detected traces of PCBs in wildlife dating back to the 1940s (Anonymous 1966). In part fueled by the Yusho accident in 1968, industrialized countries began to restrict the use of PCBs, but PCBs still remain in many products. More recently, scientists and public health officials are expressing concerns about the continuing widespread use of PCB-like flame retardants in numerous consumer products (Selin and Selin 2008).

## THE GLOBAL POLICY FRAMEWORK FOR MANAGING HAZARDOUS CHEMICALS

At the World Summit on Sustainable Development (WSSD) in Johannesburg in 2002, governments set the goal that, by 2020, chemicals should be used and produced in ways that minimize significant adverse effects on human health and the environment. In 2006, governments adopted the Strategic Approach to International Chemicals Management (SAICM) as a means for working toward this goal. This includes generating and disseminating information about chemicals for assessment and life-cycle management. SAICM also stresses the need to improve coordination between international and domestic agencies dealing with chemicals, and to include all relevant stakeholder groups in domestic management and decision-making. In addition, SAICM highlights the need for expanding capacity in developing countries and countries with transitional economies to safely manage chemicals, in part through international cooperation.

The international community has been engaged in continuous political, technical, and scientific cooperation on hazardous chemicals since the 1960s (with more disparate efforts dating back to the early 20th century). Rather than addressing all chemicals management issues under a single treaty, countries have developed four major, multilateral treaties addressing different but overlapping sets of life-cycle issues (see Table 1): the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal; the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; the 1998 Protocol on Persistent Organic Pollutants to the Convention on Long-Range Transboundary Air Pollution (CLRTAP); and the 2001 Stockholm Convention on Persistent Organic Pollutants.

**Table 1: Summary of the Four Main Chemicals Treaties**

| | |
|---|---|
| Basel Convention:<br>Adopted in 1989;<br>Entry into force in 1992;<br>172 Parties as of early 2009. | • Regulates the transboundary movement and disposal of hazardous wastes; covers chemicals if they fall under the treaty's definition of hazardous wastes.<br>• Hazardous waste transfers are subject to a prior informed consent (PIC) procedure where a party must give explicit consent before a shipment can take place.<br>• Exports of hazardous wastes are prohibited to Antarctica and to parties that have taken domestic measures banning imports.<br>• Exports of hazardous wastes to non-parties must be subject to an agreement at least as stringent as the Basel Convention.<br>• The 1995 Ban Amendment (not yet in force) bans export of hazardous wastes from parties that are members of the OECD or the EU, and Liechtenstein to other parties.<br>• The 1999 Protocol on Liability and Compensation (not yet in force) identifies financial responsibilities in cases of accidents resulting from waste transfers.<br>• Basel Convention Regional Centers have been established to aid management and meet capacity-building challenges specific to their regions. |
| Rotterdam Convention:<br>Adopted in 1998;<br>Entry into force in 2004;<br>128 Parties as of early 2009. | • Regulates the international trade in commercial chemicals using a PIC scheme.<br>• An exporting party must receive prior consent from an importing party before the export of a regulated chemical can take place.<br>• Parties are obligated to notify the Secretariat when they ban or severely restrict a chemical.<br>• Contains a mechanism for evaluating and regulating additional chemicals under the treaty. |
| CLRTAP POPs Protocol:<br>Adopted in 1998;<br>Entry into force in 2003;<br>29 Parties as of early 2009. | • Regulates the production and use of POPs pesticides and industrial chemicals listed in the treaty.<br>• Outlines provisions regarding the environmentally sound transport and disposal of POPs pesticides and industrial chemicals to be consistent with the Basel Convention.<br>• Sets technical standards for controlling emissions of unintentionally produced by-product POPs.<br>• Contains a mechanism for evaluating and regulating additional chemicals under the treaty. |
| Stockholm Convention:<br>Adopted in 2001;<br>Entry into force in 2004;<br>163 Parties as of early 2009. | • Regulates the production, use, trade, and disposal of POPs pesticides and industrial chemicals listed under the treaty.<br>• Sets technical standards for controlling the release of unintentionally produced by-product POPs listed under the treaty.<br>• Parties are required to ban the import or export of controlled POPs except for purposes of environmentally sound disposal.<br>• Contains a mechanism for evaluating and regulating additional chemicals under the treaty. |

The global Basel Convention regulates the transboundary movement and disposal of discarded chemicals classified as hazardous wastes (or part of used goods treated as hazardous wastes). Wastes are designated as hazardous under the Basel Convention if they belong to certain categories (detailed in Annex I of the treaty) and contain certain characteristics (Annex III). The treaty was adopted in 1989 and entered into force in 1992 (Kummer 1995). It prohibits export of hazardous wastes to Antarctica and to parties that have taken domestic measures to ban imports. Hazardous waste transfers from one party to another are subject to a prior informed consent (PIC) procedure. Under this PIC procedure, a party must give explicit consent to a waste import before a shipment from an exporting party can take place. Exports of hazardous wastes to countries that are not parties to the treaty must also be subject to an agreement at least as stringent as the Basel Convention.

Basel Convention regulations have been strengthened over time with a focus on North-South trade (Krueger 1999). The Basel Ban Amendment—which prohibits export from Annex VII countries (members of the OECD, the EU, and Liechtenstein) to all other parties (mainly developing countries)—was adopted in 1995. The Amendment, however, has not yet become legally binding due to a slow ratification process. The 1999 Protocol on Liability and Compensation addresses who is financially responsible in cases of incidents and damages resulting from the transfer of hazardous waste covered by the Basel Convention, but also has yet to enter into force. Parties have furthermore developed guidelines for the management of particular waste streams, including e-wastes. Fourteen Basel Convention Regional Centers located in different parts of Latin and South America, Africa, Asia, and Europe have been established to aid implementation and capacity building.[1]

The global Rotterdam Convention focuses on the international trade in commercial chemicals. Building on an earlier voluntary PIC scheme established in the 1980s (Paarlberg 1993; Victor 1998), the treaty was adopted in 1998 and entered into force in 2004. The Rotterdam Convention is designed principally to assist developing countries in deciding whether to permit the import of a chemical by increasing their access to risk informa-

1. The 14 Regional Centers are located in Argentina, China, Egypt, El Salvador, Indonesia, Iran, Nigeria, Russian Federation, Samoa, Senegal, Slovak Republic, South Africa, Trinidad & Tobago, and Uruguay.

tion and managing trade through a PIC mechanism (Kummer 1999; Emory 2001; McDorman 2004). A party can export chemicals listed in the treaty to another party only after prior consent. Parties are also obligated to notify the Secretariat when they ban or severely restrict a chemical, so that information may be made available to other parties. The Rotterdam Convention also includes a mechanism for the evaluation and possible inclusion of additional chemicals; by early 2009, the treaty covered 40 chemicals.

The regional CLRTAP POPs Protocol was negotiated under the auspices of the United Nations Economic Commission for Europe (UNECE), which comprises North America, Europe, Russia, and former Soviet republics as far east as Kazakhstan. The CLRTAP POPs Protocol was signed in 1998 and entered into force in 2003. It is designed to reduce the release and long-range transport of POPs emissions (Selin 2003). To this end, the treaty, which currently covers 16 different POPs, regulates the production, use, and environmentally sound transport and disposal of pesticides and industrial chemicals classified as POPs. The treaty also sets technical standards and guidelines for controlling emissions of POPs by-products of production and combustion processes. In addition, the CLRTAP POPs Protocol, like the Stockholm Convention, has a mechanism for evaluating additional chemicals for possible controls, and more POPs are on track to be regulated.

The global Stockholm Convention targets the production, use, trade, and disposal of POPs pesticides and industrial chemicals, as well as the release of POPs by-products (Downie 2003; Selin and Eckley 2003). The treaty was adopted in 2001 and entered into force in 2004. The Stockholm Convention, like the CLRTAP POPs Protocol, regulates the production and use of pesticides and industrial chemicals. Parties are required to ban the import or export of controlled POPs except for purposes of environmentally sound disposal. On issues of the trade in discarded POPs and their disposal, the Stockholm Convention complements the Basel Convention. Parties should furthermore minimize releases of the by-product POPs. The Stockholm Convention originally covers 12 POPs, but the treaty contains a mechanism for evaluating additional chemicals for possible controls. Several chemicals are likely to be added over the next few years.

In addition, there are a large number of regional treaties covering shared seas, lakes, and rivers that contain provisions against chemical pollution and dumping. Under the Regional Seas Programme created by United Nations Environment Programme (UNEP) in 1974, 13 action plans targeting a long list of pollutants had been created by 2009, involving over 140 countries.[2] Beyond these UNEP-led actions, there are also regional treaties for the Northeast Atlantic, the Baltic Sea, and the North American Great Lakes, among others areas, that cover a wide range of chemicals. In addition, a growing number of agreements and action plans covering shared rivers are incorporating a multitude of pollution protection measures. Such river-related actions have been in development at least since the adoption of the Convention on the Protection of the Rhine Against Chemical Pollution in 1976.

A host of intergovernmental organizations (IGOs) work on chemicals issues (Box 2). Each chemicals treaty is administered by a Secretariat that oversees and aids its implementation. UNEP—mainly through UNEP Chemicals—is centrally involved in many global and regional chemicals policy and management issues. In addition to working on a multitude of treaty implementation projects, including those under the Regional Seas Programme, UNEP led the establishment of the International Register of Potentially Toxic Chemicals in 1976 to collect and disseminate information about domestic regulations on chemicals. The UN Food and Agriculture Organization (FAO) and the WHO work on chemicals issues within their respective areas of expertise, and also collaborate in the Codex Alimentarius Commission issuing recommendations to governments on acceptable levels of pesticide residues in foods. In addition, UNEP, WHO, and FAO run the Intergovernmental Forum on Chemical Safety (IFCS).

2. The 13 actions plans are: i) Mediterranean Action Plan (adopted in 1975); ii) Red Sea and Gulf of Aden Action Plan (adopted in 1976, revised in 1982); iii) Kuwait Action Plan (adopted in 1978); iv) West and Central African Action Plan (adopted in 1981); v) Caribbean Action Plan (adopted in 1981); vi) East Asian Seas Action Plan (adopted in 1981); vii) South-East Pacific Action Plan (adopted in 1981); viii) South Pacific Action Plan (adopted in 1982); ix) Eastern Africa Action Plan (adopted in 1985); x) Black Sea Strategic Action Plan (adopted in 1993); xi) North-West Pacific Action Plan (adopted in 1994); xii) South Asian Seas Action Plan (adopted in 1995); and xiii) North-East Pacific Action Plan (adopted in 2001).

**Box 2: Major Treaty Secretariats, Organizations, and Programs Addressing Chemicals**

Secretariats

- Basel Convention: http://www.basel.int
- Rotterdam Convention: http://www.pic.int
- Stockholm Convention: http://chm.pops.int
- CLRTAP: http://www.unece.org/env/lrtap

IGOs and Programs

- UNEP Chemicals: http://www.chem.unep.ch
- UNEP Regional Seas Programme: http://www.unep.org/regionalseas
- WHO Chemicals: http://www.who.int/topics/chemical_safety
- FAO: http://www.fao.org
- ILO: http://www.ilo.org
- OECD: http://www.oecd.org
- UNITAR: http://www.unitar.org
- UNIDO: http://www.unido.org
- International Programme on Chemical Safety: http://www.who.int/ipcs
- Intergovernmental Forum on Chemical Safety: http://www.who.int/ifcs
- Global Environment Facility: http://www.gefweb.org
- Inter-Organization Programme for the Sound Management of Chemicals: http://www.who.int/iomc

NGOs and Business

- Pesticide Action Network: http://www.panna.org
- Basel Action Network: http://www.ban.org
- International Chemical Secretariat: http://www.chemsec.org
- WWF: http://www.panda.org
- Greenpeace International: http://www.greenpeace.org/international/
- Inuit Circumpolar Council: http://www.inuitcircumpolar.com
- American Chemistry Council: http://www.americanchemistry.com
- European Chemical Industry Council: http://www.cefic.be

The IFCS acts as a forum for debate among IGOs, governments, industry groups, environmental non-governmental organizations (NGOs), and scientific experts on chemical safety issues. The Global Environment Facility (GEF), for which UNEP, the United Nations Development Programme (UNDP), and the World Bank are implementing agencies, has been expanded to fund projects on chemicals management associated with the implementation of the major treaties. The International Labour

Organization (ILO) focuses on issues of workplace safety. The OECD works to coordinate testing requirements and establish common guidelines for data generation and sharing among its member states. The United Nations Institute for Training and Research (UNITAR) works with developing countries to improve domestic capabilities for chemicals management.

ILO, OECD, and UNITAR also work with developing countries to implement the Globally Harmonized System for the Classification and Labeling of Chemicals, which is designed to facilitate identification of chemicals that are traded and transported between countries. Those countries that did not already have domestic labeling schemes are expected to adopt the global one, while countries that already had domestic schemes in places should harmonize those with the global system. The WHO is also working on harmonizing its long-standing classification scheme of acute toxicity with this system. Finally, the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) works towards fulfilling the WSSD 2020 goal for sound management of chemicals in collaboration with, among others, FAO, ILO, OECD, UNEP, WHO, UNITAR, and the United Nations Industrial Development Organization (UNIDO).

Given the magnitude of the international trade in chemicals, the strong trade and market dimensions of international chemicals management, and the economic and political influence of the chemicals industry, it is hardly surprising that many industry associations and multinational firms are active participants in the development of international chemicals policy.

Many environmental NGOs are active in chemicals policy and management issues. This includes not only major organizations such as the World Wildlife Fund (WWF) and Greenpeace, but also more specialized advocacy groups such as the Pesticide Action Network and the International Chemical Secretariat. These groups lobby for treaty developments as well as engage in awareness-raising and capacity building. The Basel Action Network is a key advocacy group on waste issues, including the trade in e-wastes. In addition, Arctic indigenous groups have been a major presence in the development of international chemicals policy since the 1990s. In particular, the Inuit Circumpolar Council, representing several Arctic indigenous communities, lobbied to ensure that the vulnerability of the Arctic region and its indigenous populations are explicitly recognized under both the Stockholm Convention and the CLRTAP POPs Protocol (Watt-Cloutier 2003; Selin and Selin 2008).

Given the magnitude of the international trade in chemicals, the strong trade and market dimensions of international chemicals management, and the economic and political influence of the chemicals industry, it is hardly surprising that many industry associations and multinational firms are active participants in the development of international chemicals policy. The American Chemistry Council (ACC) and the European Chemical Industry Council (CEFIC) are two leading industry organizations that together with major firms regularly attend international scientific and political meetings. Private sector representatives are also in frequent contact with state officials and/or are included in national delegations as they try to shape policy making and outcomes. Many private-sector actors are focusing on the control of specific chemicals and the design of trade restrictions.

## FOUR SETS OF MANAGEMENT CHALLENGES

Global policy and management of hazardous chemicals have been greatly expanded by national governments in collaboration with a host of IGOs and NGOs over the past four decades. This has included a much-needed strengthening of life-cycle controls of a small set of chemicals through the adoption of the major treaties discussed earlier. As a result, some important progress has been made in improving environmental and human health protection from hazardous chemicals. However, there are several remaining challenges critical for the fulfillment of the WSSD goal on the safe production and use of chemicals by 2020. Among these, four sets of challenges stand out:

1) Enhancing ratification and implementation of existing regulations;
2) Expanding risk assessments and controls;
3) Improving management capacity and raising awareness; and
4) Minimizing generation of hazardous chemicals and wastes.

First, there is a need to increase global and regional treaty ratification and implementation of existing regulations. Increased ratification of all four major chemicals treaties would increase the number of states that take on formal responsibilities as well as strengthen the treaties' position under international law. While 171 countries and the EU have ratified the Basel Convention, the United States—one of the world's largest waste exporters—is not a party. The Basel Convention Ban Amendment has also not received sufficient ratification to enter into force, while even fewer countries have signed the Protocol on Liability and Compensation. More than 160 countries and the EU are parties to the Stockholm Convention while the EU and 127 countries have ratified the Rotterdam Convention. However, the United States and many developing countries are not parties. Twenty-eight countries and the EU have ratified the CLRTAP POPs Protocol, but both Russia and the United States remain non-parties.

The fact that there are multiple treaties covering partially different life-cycle issues raises important concerns about treaty synergies. The outcome in a synergetic situation is more than the mere sum of the different parts; rather, value is added in that the total result is greater than what could have been achieved by each piece working separately. In contrast, conflicts arise when the objectives and/or operation of two or more interrelated policy instruments and management efforts contradict each other. Then, the separate policy instruments and management efforts are negatively affecting each other, hampering governance. The desire to capture regulatory and management synergies was a major driving force behind the establishment of SAICM as well as the recent creation of an Ad Hoc Joint Working Group to enhance cooperation and coordination of political and technical activities under the Basel, Rotterdam, and Stockholm Conventions.

Better coordination of regulations and management efforts across treaties would also make it easier for parties to meet their commitments. There are obvious benefits of closer cooperation between the different Secretariats and Conference of the Parties in many areas. Expanded cooperation between Secretariats and subsidiary bodies could not only help save limited resources, but also make it easier to improve regulatory and management consistency across agreements. Increased cooperation can also minimize (if not eliminate) important issues falling through regulatory or administrative "cracks" between treaties (Downie, Kruger, and Selin 2005). This, however, is made difficult by the fact that there is uneven membership across major chemicals treaties—which is another reason to promote increased ratification (there will, of course, always be differences in membership between regional and global treaties).

Second, there is a need to accelerate risk assessments and expand regulations beyond the small number of chemicals that are currently subject to comprehensive controls. Industrialized and developing countries have only scant data on emissions, environmental dispersion, and ecosystem and human health effects of most chemicals. Gathering data and making assessments are costly processes, and there are compelling financial reasons to expand collaborative assessment efforts through IGOs such as the OECD and UNEP. Domestic and international regulations should also be expanded beyond current ones, including by using existing treaty mechanisms. Several non-regulated POPs-like chemicals have been detected in remote areas. For example, concentrations of polybrominated diphenyl ethers (PBDEs), used as flame retardants in numerous products, increased exponentially in Canadian Arctic seals between 1981 and 2000 (Ikonomou, Rayne, and Addison 2002), and can also be detected in environmental samples from other regions.

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The use of non-POP pesticides is also continuing in many parts of the world. Even if these do not strictly meet treaty criteria of a POP, a large number fall under WHO class I (Extremely and Highly Hazardous) and class II (Moderately Hazardous) of toxic pesticides (Mancini et al. 2005). This highlights a need to consider additional pesticides for inclusion in the Rotterdam Convention as well as increase participation by IGOs such as

FAO, WHO, and UNITAR on pesticide management. This need includes expanding international and domestic efforts on integrated pest management, which involves using a combination of environmentally friendly methods designed to significantly reduce and, where possible, eliminate the use of pesticides. Such methods may involve increased use of pest-resistant crop varieties, the employment of local insects for pest control, the design of more effective crop rotation schemes, and improved soil management.

To effectively expand risk assessments and regulations, public authorities must find better ways of integrating scientific work with decision making. Scientific work on identifying and evaluating chemical risks is continuously developing. Domestic risk assessments on individual chemicals in the past have often consumed a large amount of resources without necessarily producing policy-relevant information (Eckley and Selin 2004; National Research Council of the National Academies 2008). Similarly, evaluations of candidate chemicals for possible controls under major chemicals treaties are often long and arduous processes (Kohler 2006). Consequently, there is a need for international bodies and national governments to design more streamlined mechanisms for conducting quicker risk assessments of a large number of chemicals to produce more policy-relevant information.

To this end, the creation of an Intergovernmental Panel of Chemical Pollution, loosely modeled after the Intergovernmental Panel on Climate Change, was recently proposed (Scheringer 2007). The idea behind this proposal is that expanding assessments of hazardous chemicals on a needed scale is such a momentous task that it requires extensive international collaboration. If established, an Intergovernmental Panel of Chemical Pollution could build on existing global and regional initiatives to collect and synthesize scientific and socio-economic data. Reports published by the panel could also help identify critical information gaps, helping target future assessment efforts. A more centralized assessment process could furthermore help ensure more consistent policy making across different treaties. However, the benefits of an Intergovernmental Panel of Chemical Pollution should be carefully considered in relationship to expected costs of operation before this proposal moves forward.

Third, it is critical to better link global and local governance efforts, including improving regional and domestic management capacities and raising local awareness about the dangers posed by hazardous chemicals and chemicals wastes. All countries face important capacity issues, but many developing countries face particular difficulties ensuring safe management of hazardous chemicals and wastes. This includes more effectively addressing illegal trade in chemicals and wastes. The release of by-products such as dioxins and furans—for which most countries lack reliable emissions data —also pose a major management challenge. Developing countries typically lack access to best available techniques and best environmental practices for limiting emissions of by-products from industrial manufacturing, combustion processes, and waste management.

The Basel Convention Regional Centers help to coordinate management activities under different chemicals treaties. The Regional Centers can play many important management roles, including in areas of information generation and sharing, border controls, and building of domestic capabilities for regulation, emission prevention, and remediation of contaminated sites. On all these issues, the Regional Centers can be used as organizational nodes linking global capacity building efforts by, for example, UNEP, FAO, WHO, UNITAR, and treaty Secretariats, with the specific regional management needs of local authorities and handlers of chemicals and wastes (Selin and Selin 2006). The Regional Centers could also be used to operate more ambitious treaty mechanisms for monitoring and enforcement, which would increase opportunities to enhance implementation and compliance across different chemicals treaties.

Countries' statements and actions during international meetings, however, demonstrate that many remain protective of national sovereignty. As a result, most industrial and developing countries are unwilling to give much independent authority to Secretariats on issues of data collection and monitoring (and even less so to give Secretariats or other treaty bodies the right to take action against an individual member that does not fulfill its obligations).

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National Implementation Plans submitted by parties to the Stockholm Convention, together with numerous scientific and socio-economic studies, show that better chemicals management also involves raising awareness. This includes enhanced education about chemical hazards and better training of handlers and users in selecting a safe chemical control strategy based on which specific pesticide is used and what it is intended for. Key issues for the safe handling of chemicals include the appropriate application of pesticides for targeting vector-borne diseases, the effective use of pesticides in agriculture, the practical use of hand-operated and power-operated equipment, and the wearing of protective gear (WHO 2006). Yet, raising awareness and training are not always enough. The authors of a recent study of acute pesticide poisoning among cotton growers in India concluded:

> "The extent of pesticide poisoning among farmers and workers in developing countries is worrying. In the extreme hot weather of the tropics, protective gear does not seem to be a viable solution to eliminate occupational risks. Educating farmers about the pesticide hazard alone has not achieved significant results. The solution seems to be in the replacement of pesticides with non- or less toxic alternatives. One example of such alternatives can be found in the integrated pest management approach" (Mancini et al. 2005, 231–232).

The India study illustrates the fact that even in cases where farmers are educated about health risks and protective gear is available, safety equipment may still not be used. This is because available safety equipment can be prohibitively expensive for rural farmers, and may also be cumbersome to use in hot weather conditions in tropical and subtropical regions. Thus, there is a need for IGOs, states, and NGOs to collaborate more closely on making protective clothing more readily available for farmers in poor areas as well as to support the development of protective clothing and techniques that are more appropriate for tropical conditions. As suggested by the authors of the India study as well as many other experts, these efforts should be carried out in the context of expanding the use of IPM practices in regions and countries that are still lagging behind in their application (Nwilene, Nwanze, and Youdeowei 2008).

Fourth, efforts to minimize the generation of hazardous chemicals and wastes should be intensified in both industrial and developing countries. This requires expanded collaboration between public and private sector actors. The most effective way to protect human health and the environment from risks posed by hazardous chemicals and wastes is, of course, to avoid producing and using them in the first place. However, global efforts on chemicals to date have largely prioritized the management of known or suspected hazardous chemicals, rather than creating measures to prevent the future development of new dangerous chemicals. In addition, the Basel Convention has focused largely on developing controls on the transboundary movement of wastes and technical guidelines for waste management, paying very little attention to stipulations on waste minimization.

Rapidly growing levels of e-waste—and the development of national, regional, and global policy and management efforts to handle e-waste—further connect issues of hazardous chemicals and waste management (Selin and VanDeveer 2006). The introduction of market-based incentives and different kinds of supportive governmental regulations making firms increasingly responsible for their products—including electronic and electrical goods—throughout their entire life cycle could play a significant role in stimulating more effective waste management and minimization efforts. E-waste is also attracting more attention under the Basel Convention. This includes the Mobile Phone Partnership Initiative launched in 2002 through which leading mobile phone manufacturers committed to increase their responsibility for mobile phone recovery. This and other corporate responsibility efforts, however, remain limited in scope and are entirely voluntary.

## THE NEED FOR NEW GUIDING PRINCIPLES AND APPROACHES

As discussed earlier, several policy and management measures could help ameliorate the chemicals problem. However, more fundamental changes are ultimately needed for successful longer-range management. Policy makers have traditionally operated within legal and conceptual frameworks that assume that a chemical is harmless until proven harmful. As a result, public officials have held off regulating any chemical until they believe that there is conclusive evidence that it has caused specific damage. This reactionary approach, however, has resulted in much harm, as it has taken a long time to regulate severely hazardous chemicals. It is also a very time-consuming process of dealing with one chemical at a time. Although not all are still in use, over 100,000 chemicals have at one point been registered for the EU market. While there is no reliable data on all kinds of chemicals used globally, it is safe to assume that more or less any chemical used in Europe has also been used elsewhere.

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In a comparative study of several environmental and human health issues, Harremöes et al. (2002) found that decision makers were more likely to not regulate something that later turned out to be harmful (so-called 'type 1' error), than to err on the side of caution and regulate something despite uncertainty about environmental and human health risks. Applying the precautionary principle on issues characterized by uncertainty and risks aims to limit these kinds of type 1 errors (Eckley and Selin 2004). Germany and Sweden were among the first countries to introduce the precautionary principle in domestic legislation and regulation of risk in the early 1970s. Beginning in the mid-1980s, precautionary language was included in international agreements with strong support from European countries. EU treaties since the early 1990s state that precaution should guide all EU environmental policy making, including on hazardous chemicals (Tickner and Raffensperger 2001; Selin 2007).

A regulatory approach based on the precautionary principle, as defined in Principle 15 of the 1992 Rio Declaration on Environment and Development, is based on the idea that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation." This definition of the precautionary principle is cited or referred to in numerous international statements and treaties on chemicals. However, countries differ with respect to the extent that they embrace the precautionary principle. For example, the United States has voiced much skepticism about the precautionary principle in environmental forums. US federal chemicals legislation also remains focused on proving harm before taking regulatory action. This limits the ability of effective environmental and human health protection under conditions of uncertainty (National Research Council of the National Academies 2008).

One problem with the traditional procedure for assessing and managing hazardous chemicals is that the burden of proof is on regulators to prove that a chemical is not safe, rather than the producer and/or seller having to produce data demonstrating that a substance is not likely to cause adverse environmental and human health effects. This approach leaves little room for incorporating precautionary thinking during assessment and decision making processes, especially if each single chemical has to be the subject of a separate, extensive technical risk evaluation (Eckley and Selin 2004). Furthermore, it is typically up to domestic regulatory authorities—rather than firms producing or selling chemicals—to generate scientific data necessary for carrying out risk assessments. This has turned out to be a slow and arduous process in any country. The vast majority of chemicals that are regularly sold and used have not been subject to any in-depth scientific assessments (including many that have been on the global market for decades).

While much chemicals policy remains reactionary, the EU is building a more proactive approach through the Registration, Evaluation and Authorization of Chemicals (REACH) regulation, which was adopted in 2007 (Selin 2007). REACH aims to more effectively generate policy-relevant information by requiring firms to submit risk assessment data (Selin 2007). Commercial handling of any chemical covered by REACH is prohibited unless it is proven to be harmless, adequately controlled, or that societal benefits outweigh costs. REACH specifically targets chemicals that are CMR (carcinogenetic, mutagenic, and toxic for reproduction), PBT (persistent, biological accumulating, and toxic) or vPvB (very persistent and very biological accumulating) based on their inherent characteristics (rather than proven harm). All such chemicals have to be individually authorized by authorities before they can be sold on the EU market. REACH also contains guidelines for the phase-out and substitution of hazardous chemicals to less harmful substances and/or non-chemical alternatives.[3]

More proactive and precaution-based regulatory structures not only help reduce environmental and human health risks, but may also reduce public and private long-term costs of cleaning up contaminated areas. Industrialized and developing countries face significant problems with sites contaminated by hazardous chemicals.

Furthermore, more proactive and precaution-based regulatory structures not only help reduce environmental and human health risks, but may also reduce public and private long-term costs of cleaning up contaminated areas. Industrialized and developing countries face significant problems with sites contaminated by hazardous chemicals. In an infamous case, a chemicals and

3. See also the REACH SIN (Substitute It Now) list compiled by the International Chemical Secretariat in collaboration with several other NGOs. This list is intended to push public agencies and firms to accelerate substitution of hazardous chemicals: http://www.chemsec.org/list.

plastics company in Love Canal near Niagara Falls in upstate New York dumped large amounts of toxic chemicals in an old canal bed between the 1930s and the 1950s. In the 1970s, these chemicals began leaking through to the school and housing tract that had recently been built on the old dumpsite. Health effects linked to high-level chemicals exposure in the Love Canal case included high birth defect and miscarriage rates, liver cancer, and high incidence of seizure-inducing nerve disease among small children (Layzer 2006, 54–80).

More recently, violent riots erupted in the Chinese city of Huaxi in 2005 in response to widespread air, water, and land pollution from an industrial park housing 13 chemical factories (Yardley 2005). The longer-term financial costs of cleaning up this and other contaminated areas all over the world are enormous. The US Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or the Superfund Act) was passed in 1980 to deal with sites like Love Canal. In 2007, CERCLA listed 275 priority chemicals and heavy metals commonly found at contaminated sites. The US government spent $1.2 billion on Superfund projects in 2006 alone (Sissell 2007). While 24 sites were completed in 2007, there are more than 1,250 unaddressed sites on the Superfund National Priority List (and more will be added in the future) (Clinton 2008).

The EU has also introduced more proactive policy on hazardous substances in electronic goods and e-waste. Recent EU directives on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) and waste electrical and electronic equipment (WEEE) are designed to phase out several hazardous substances from most kinds of electronic goods and increase recycling of such goods (Selin and VanDeveer 2006). European consumers are required to return a large number of discarded electronic goods to the producers (rather than municipal authorities). Producers are then responsible for recycling, reprocessing, and safely disposing of these wastes. In this respect, the WEEE and RoHS directives—together with the REACH regulation—significantly increase producer responsibility and take a notable preventive approach to hazardous chemicals and e-wastes.

The benefits of a more proactive approach to the use of hazardous substances in goods and e-waste management should also be viewed from a longer-term perspective. Phasing out hazardous substances from goods helps reduce risks to the handlers of these goods once they are discarded, which could be decades after they were first sold. E-waste already poses significant health risks to many workers, particularly in developing countries that have become large importers of e-waste but lack the resources to deal with it in a safe manner. These risks will only increase unless more measures are taken to limit the use of hazardous substances in goods. Hazardous substances also leak from e-waste into the ground, contaminating land used for housing and agriculture as well as drinking water. Such problems will linger for decades and generate significant clean-up costs for firms and public authorities.

Finally, green chemistry—the utilization of principles that reduce or eliminate the use or generation of hazardous substances in the design, manufacture, and application of chemicals —is an effort to better incorporate environmental and health concerns into the development of new chemicals (Anastas and Warner 1998). To target the problem with chemicals at its source, green chemistry proponents stress the importance of synthesizing substances with little or no environmental toxicity. Chemicals should also be designed so that at the end of their functional lives they quickly break down into innocuous degradation products, as part of a broader effort to create a more sustainable use of materials (Geiser 2001). Broader public and private sector acceptance of green chemistry principles is a critical step towards ensuring the safe production and use of chemicals.

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## CONCLUSION

As hazardous chemicals continue to pose significant environmental and human health problems, improved management and the adoption of more precautionary policies and approaches are greatly needed. This includes strengthening existing controls, shifting data generation tasks away from public authorities to firms and industry organizations, expanding producer responsibilities for phasing out the use of hazardous chemicals and managing wastes, and, ultimately, developing new, less harmful chemicals. While the chemicals industry expresses great concern about the financial burden of REACH and other recent EU policies introducing some of these changes, one study estimated that the total cost for implementing REACH over 11 years would be less than 0.1 percent of the industry's sales revenues (Ackerman and Massey 2004). Any short-term financial costs should also, of course, be judged against the many longer-term benefits of better management structures.

The influence of REACH, RoHS, and WEEE increasingly is noted outside of Europe as more proactive policies attract much attention from decision makers around the globe (Selin and VanDeveer 2006; Buck 2007; Selin 2009). Policy makers from large producers and users of chemicals and electronic goods such as China, Japan, South Korea, and the United States are all copying ideas and aspects of recent EU policy, helping to raise global standards.[4] These policy developments also engender changes in the private sector that help drive positive changes worldwide. Firms that are adjusting to comply with new product and waste standards in the EU and elsewhere are also changing production processes and goods sold in other markets. Similarly, advocacy organizations across countries use policy innovations on chemicals and wastes in another jurisdiction to advocate for similar regulatory changes within their own jurisdiction.

4. For a database on U.S. state-level actions, see: http://www.chemicalspolicy.org/uslegislationsearch.php.

Unfortunately, assessments and policy developments under the main chemicals treaties and SAICM continue largely to proceed down traditional and reactive tracks; the important changes in regulatory approaches and principles that can be seen within the EU and elsewhere are not yet sufficiently reflected in international law. It is, however, only through the incorporation of more proactive and precautionary approaches in procedures for assessment and regulation that the main chemicals treaties can become a truly effective force for life-cycle management and environmental and human health protection. Such fundamental changes should also be accompanied by much more aggressive efforts to address the four sets of management challenges discussed earlier. Doing all of this requires comprehensive longer-range thinking and planning by the international community, and is necessary for achieving sustainable development.

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