Spatial Patterns of Hazardous Waste Generation and Management in the United States

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Hazardous waste is generated in the production of almost all consumer goods, especially those that contain plastic. The United States is the world leader in generating hazardous waste with 214 million tons produced in 1995. The majority of this waste was wastewater generated by the fifty largest generating facilities, disproportionately concentrated along the western Gulf Coast. The largest facilities also treat most of their waste on site, particularly wastewater. Most smaller generators send waste an average of 200 miles for treatment or disposal. Among both citizens and state governments there is resistance to local siting of waste facilties. Local resistance has convinced businesses or government agencies to look elsewhere to site a proposed facility. State efforts to directly control the flow of hazardous waste have not been successful due to court challenges from industry and subsequent decisions that state restrictions violate the Commerce Clause of the U.S. Constitution. Taxes on both in-state and out-of-state waste have proven effective at reducing in-state waste disposal. **Key Words: hazardous waste, environmental policy, United States.**

Introduction

Consumers in the industrialized world are accustomed to a wide range of goods such as home appliances, automobiles, and designer clothes. The production of such goods, or of anything that contains plastic, metals, or synthetic fiber, generates hazardous waste. The U.S. Environmental Protection Agency (hereafter EPA) defines hazardous waste as: 1) readily or spontaneously ignitable, 2) corrosive (highly acidic [pH $\leq$ 2] or alkaline [pH $\geq$ 12.5]), 3) reactive (explosive or unstable in combination with air or water), or 4) toxic (a sufficient concentration of any of 40 chemical compounds shown to be toxic in laboratory tests, including: benzene, chromium, lead, ketone, toxaphene, and vinyl chloride) (LaGrega et al. 1994, 49–50; Code of Federal Regulations 1997, 21–24). Most of these compounds are inorganics diluted in water, with some organic liquids and solid waste (Baker and Warren 1992, 26). Radioactive waste, waste from oil and gas drilling, and most mining wastes are classified separately.[1]

This paper addresses three questions about waste in the United States. First, where is hazardous waste generated and why? Second, what is the fate of hazardous waste, i.e., where is it treated, shipped, and/or disposed of, and why? And third, how have state governments and citizens attempted to control the location and movement of hazardous waste? By understanding the answers to these three questions, geographers may better inform local and national debates over the siting of facilities that generate or handle hazardous waste.

The paper is built on an empirical framework with sections devoted to each of the three questions posed above: 1) generation of hazardous waste, 2) the fate of waste, and 3) geographic control of waste. Central to each section are detailed maps that show the spatial pattern of states and facilities involved in hazardous waste. The maps are supported by a narrative explaining the historical and political context of these facilities, and the states where they operate.

Sources of Data on Hazardous Waste in the United States

Hazardous waste in the United States is tracked by a manifest system mandated by the Resource Conservation and Recovery Act (RCRA) of 1976. Since the early 1980s these manifests have produced a detailed record of waste from its generation through shipping and/or treatment to final disposal, termed "cradle-to-grave" coverage. These data are reported by facility managers to individual states and, in turn, to the EPA's Office of Solid Waste and Emergency Response, which makes the data available publicly as part of the National Biennial RCRA Hazardous Waste Re-

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porting System (BRS). This reporting system includes:

- The name, address, and technical capability of every large quantity facility that generates or manages hazardous waste;
- Generation and management data, including the name and wet weight of each substance handled by each facility, the method of treatment or disposal, the weight and destination of shipments, and short comments about the waste; also, similar information for facilities receiving waste from off site;
- General descriptions of the processes used to minimize, recycle, treat, or dispose of waste.

It is significant that RCRA data only include large facilities, those that generate or handle over 1,000 kg of waste in at least one month during the year (or 1 kg in any month of acute hazardous waste, composed of chemicals known to be toxic to humans or lethal to rats in small exposures). Hundreds of thousands of small generators, for example, auto repair shops and medical offices, are not included in the RCRA total. The federal government only regulates such waste as it relates to legislation such as the Clean Water Act. State regulation of small generators varies from no reporting requirements in some states to stricter requirements than the RCRA's in others.

A second source of data that is important to this study is the *Toxics Release Inventory* (TRI), a database including reported discharges of any of over 600 chemicals deemed potentially hazardous by the Environmental Protection Agency. This database was created under section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA), which mandates a public record of the name and amount of compounds released, and the medium (air, land, or water) into which the release occurs.

Both BRS and TRI data are currently accessible free online from the "Right to Know" network (www.rtk.net), which offers a wide range of federal data on housing, sustainable development, and the environment in a user-friendly format. For custom applications, raw BRS data is also presently available in ASCII file format at www.epa.gov/epaoswer/hazwaste/data/#brs.

Generation of Hazardous Waste

The United States is the worldwide leader in generating hazardous waste. In 1991 large quantity generators produced 305 million tons of RCRA-defined hazardous waste, well over one ton for each person living in the country (U.S. EPA 1997c, 2). Germany was a distant second in 1991 with 0.23 tons generated per person (Cutter 1993, 113). The major generator of hazardous waste, the chemical industry, is a key export sector for the United States. In 1997, the United States exported $70.8 billion worth of chemicals for a surplus of $20.5 billion (Storck 1998, 18).

The most recent data available are for 1995 when 214 million tons of RCRA hazardous waste were produced, down from 258 million in 1993 and 305 million in 1991. Comparison with biennial reports prior to 1991 is problematic because several types of previously nonhazardous waste were redefined as hazardous by 1990's toxicity characteristic rule (U.S. EPA 1997c, 2). However, the EPA estimates that of the 214 million tons in 1995, at least 63 million tons were in the categories added in 1990, leaving at most 214 − 63 = 151 million tons that would have been considered hazardous prior to 1990 (U.S. EPA 1997c, ES-4). In 1986, under the less inclusive rule, 290 million tons of RCRA hazardous waste were generated (Baker and Warren 1992, 29). Thus, the total for 1995 shows a sharp drop (nearly 50%) of these hazardous wastes over a nine year period (Fig. 1).

This reduction in hazardous waste is the result of a combination of public/private efforts

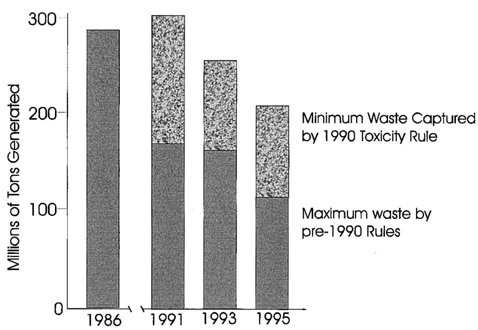

Figure 1: *RCRA hazardous waste generation totals, showing 1991, 1993, and 1995 totals by 1986 rules, and additional waste included due to the 1990 toxicity rule.*

to minimize waste, the cost of waste disposal, and increased overseas operations. The EPA established the Waste Minimization National Plan to help businesses and government agencies voluntarily reduce the most persistent, bioaccumulative (concentrating over time in living organisms), and toxic wastes by 25% from 1991 to 2000, and by 50% from 1991 to 2005. The plan includes grants to researchers to develop new ways of minimizing hazardous waste and education to highlight ways that plant managers and engineers may reduce pollution at the source without curtailing production. The EPA also stresses to business the public relations advantages of pollution prevention (U.S. EPA 1997b). The second factor in the sharp reduction of hazardous waste is cost. The price of handling hazardous waste rose dramatically when regulations such as the RCRA and the Toxic Substances Control Act were promulgated during the 1980s, spurring industry to reduce waste. In so doing, many facilities found that they could also save money by operating more efficiently, buying smaller amounts of chemical inputs and recycling (Beroiz 1990, 263–71; Duke 1994, 50–5; Gashlin and Watts 1994, 437–38). Finally, corporations moved more polluting operations out of the U.S. to countries where regulations are less stringent or less consistently enforced (*Economist* 1993, 50).

Distribution of Hazardous Waste in the U.S.

The 1995 total of 214 million tons of RCRA hazardous waste was generated by 20,873 large quantity generators (U.S. EPA 1997c, I-2). The largest single facility total was over 38 million tons for Tennessee Eastman Company, a division of Eastman-Kodak, in Kingsport. On the low end of the range, numerous facilities generated less than one ton of waste. The median-value facility generated 23.6 tons (Fig. 2).

State-level data show that five states—Texas, Tennessee, Louisiana, Illinois, and Michigan—generated over 70% of the national total during 1995 (Fig. 3). While showing some clustering, however, state-level data fail to capture the extent of regional concentration among industries that produce hazardous waste. To discern this concentration, we must look at individual facilities. Of the 20,873 generating facilities listed, the top 50 alone generated 178 million tons (83.3%) of the national total (U.S. EPA 1997c, I-8).

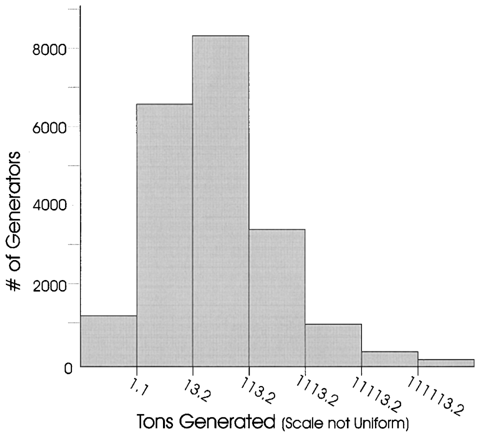

Figure 2: *Number of generators vs. tons of RCRA hazardous waste generated, 1995.*

Facility-level data show that 98.7% of Tennessee's total of 38,686,622 tons was generated by Tennessee Eastman. In another example, one factory, the Dow–Midland Plant Site, accounted for 72% of Michigan's 1995 hazardous waste total, and E.I. Dupont–Chambers Works produced 95% of New Jersey's 10.3 million tons of waste. Furthermore, Texas and Louisiana were home to 27 of the top 50 generators in the country, accounting for 76.5 million tons of waste, all located on a 400-mile strip stretching from San Antonio, TX in the west along the Gulf Coast east to the Mississippi River Delta (Fig. 4) (U.S. EPA 1997c, I-8).

Thirty-five of the top 50 generators were petroleum refining/petrochemical plants for whom equipment and labor are expensive, and economies of scale are vital. From an historical perspective, this prevalence of petroleum among the largest generators helps to explain the Texas-Louisiana concentration shown in Figure 4. United States automotive production was surging in the 1920s just as the petroleum reserves of the Gulf Coast Embayment were coming on line. The region's oil and natural gas reserves then became keys to the burgeoning petrochemical industry of the 1930s and 1940s that produced the first mass market synthetic rubber and plastics (Davis 1984, 117–8). In fact, early feedstocks for petrochemicals were refinery byproducts, not useful in producing gasoline (Spitz 1988, 513–5). Shell, Dow, and

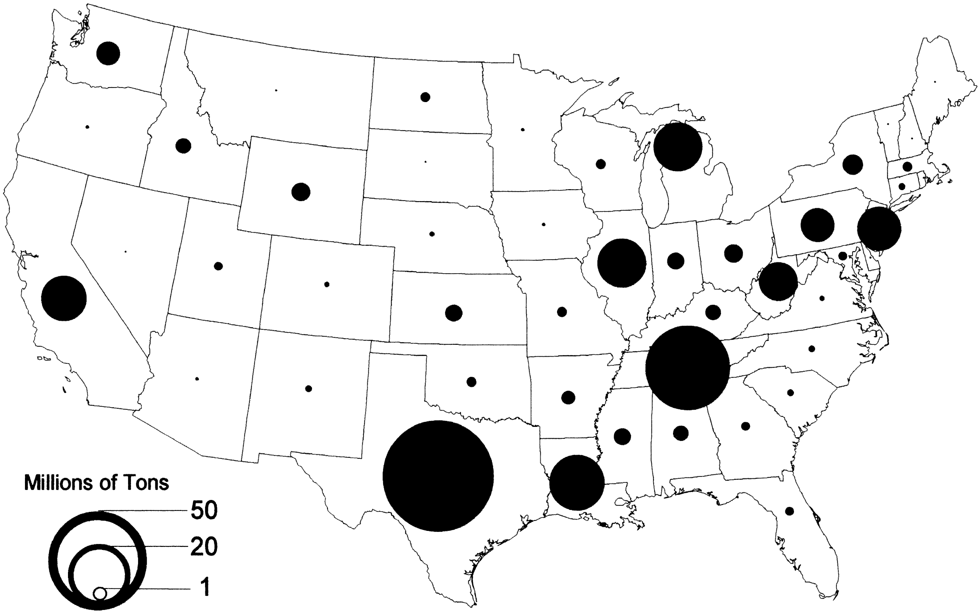

Figure 3: *RCRA hazardous waste generation, by state, 1995.*

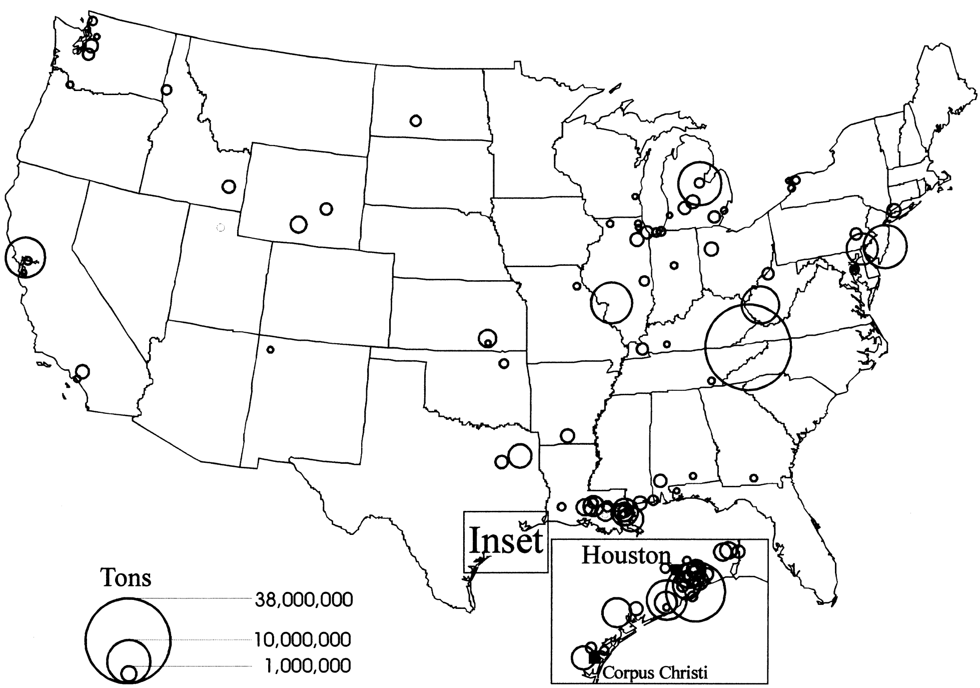

Figure 4: *Top 100 RCRA hazardous waste generators, 1995.*

Union Carbide were among the corporations that located petrochemical facilities on the Gulf Coast just before World War II, drawn by the availability of natural gas and the federal government's demand for synthetics to support the building war effort. Most such companies operated state-funded factories during the war, acquiring them at favorable prices when hostilities ceased. Other factors in the wartime location of petrochemical facilities on the Gulf Coast of Texas include its distance from conflict in the Atlantic and Pacific, and Houston's strong political influence on federal synthetics funding (Pratt 1980, 94; Chapman 1991, 66–78).

Infrastructure and services supporting petroleum-based industries along the Gulf Coast are the basis of the industries' continued presence there, despite the fact that the petroleum or natural gas processed today is as likely to be from Latin America as it is from Texas or Louisiana (Koen 1995, 23; *Oil and Gas Journal* 1997, 40). These companies built ever larger processing facilities near their raw material, saving significantly on per unit production and transportation costs. Short haul, high volume pipelines were built to transport volatile substances such as natural gas and ethylene, linking a complex regional web of supply and production facilities. Also, low real transportation costs and relatively low wages and rates of unionization along the Texas-Louisiana coast have dampened interest in moving facilities closer to petrochemical users in the North. Finally, a combination of economic pragmatism, a lack of regional planning, and socioeconomic inequality (Goldsteen 1993, 6–8, 24) has perpetuated a culture on the western Gulf Coast that has come to accept and depend on the petroleum industry more than other regions of the U.S. likely would. In the 1990s, the petrochemical industry is more concentrated than ever, with over 90% of U.S. production capacity in Texas and Louisiana (Chapman 1991, 120).

The immense weights of hazardous waste recorded in these data are due to the role of water as a cleanser and carrier of pollutants from industry. Process wastewater that contained suspended toxic material or that was too acidic or too alkaline to be released without treatment accounted for 203 tons (95%) of the hazardous waste generated in 1995 (U.S. EPA 1997c, ES-3). Concentrated solids, sludges, and liquids made up only 11 million tons (5%). Moreover, the *dry* weight of toxics within the wastewater averages only 5% of its total weight (Allen and Behmanesh 1992, 95). So, the dry weight of 203 tons of wastewater in 1995 was only a shade over 10 million tons, making the year's overall waste total only about 21 million tons of dry weight. It should also be noted that not all hazardous wastes are created equal. Thousands of tons of a sodium hydroxide solution are less of a threat to human health than a much smaller amount of an acutely hazardous substance such as dioxin. U.S. EPA is developing a hazard-ranking system, but none is included in the generation data.

The Fate of Hazardous Waste

Prior to the late 1970s, most chemical wastes went untreated into the environment, first into waterways and later, as water regulations tightened, into land dumps, ponds, and lagoons (Colten and Skinner 1996, 53–68). The legacy of this dumping is over 100,000 open, contaminated sites scattered throughout the country, only the most serious 1,200 of which are on the Superfund National Priorities List for clean up (U.S. General Accounting Office 1987, 12; Colten 1990, 143; U.S. EPA 1999). But the RCRA manifest system, implemented in the early 1980s, is meant to ensure that hazardous waste is only transported, treated, and disposed of in a limited number of approved ways (LaGrega et al. 1994, 43–6).

Transporting hundreds of thousands of tons of hazardous waste is legally risky, politically unpopular, and most important, expensive. Thus, most of the largest generators treat or store the bulk of their waste on site, especially easily treated wastewater. Forty-three of the top 50 *generators* of waste are also among the top 50 waste *managers* in the country. In 1995, of the 178 million tons of waste generated by the top 50 facilities, only 1.1 million tons (0.6%) were sent off site for treatment or disposal (U.S. EPA 1997b). For example, of 38 million tons generated, Tennessee Eastman Company sent only 4,737 tons of waste off site, mostly sludges from wastewater treatment or other solids, primarily for disposal in landfills or deep injection wells. The rest, mostly organic wastewater, was treated at the plant by biological degradation (U.S. EPA 1997f).

Acidic wastewater with pH ≤ 2.0 or alkaline wastewater with pH ≥ 12.5 is often treated by neutralization, simply mixed with its counterpart to achieve the pH of water (7.0). It is then released into surface streams or municipal sewers (LaGrega et al 1994, 16). Some wastewater defined as hazardous by RCRA is slowly released without treatment to streams and sewers under the Clean Water Act, section 402 or 307(b) permits, the principle being that it quickly dilutes below hazardous concentrations when released slowly into moving water.

Description of Patterns

10.7 million tons of RCRA hazardous waste were transported off site for treatment or disposal in 1995. Most of this waste came from facilities generating from 0.2 to 10,000 tons of waste, facilities without equipment to treat it on site. To analyze patterns of waste shipments, I systematically sampled the list of large quantity generators, choosing every 100th facility (U.S. EPA 1997d). Generation and treatment data, and the distance of shipments of over one ton of waste for each sampled facility (n = 209) were recorded.

Treatment—Of 209 facilities, only eight (4%) treated RCRA waste on site, close to MacMillan's estimate of 5% (1993, 30). All three facilities that generated over 40,000 tons of waste all did on-site treatment while only five of the remaining 206 smaller plants (2.5%) treated any waste on site. Economies of scale, then, are important in the treatment of hazardous waste as well as the processes that generate it. While some smaller treatment processes can be economical, most waste generators opted in 1995 to send up to hundreds or even thousands of trucks or train cars of waste off site for treatment rather than deal with it themselves.

Shipping—The destinations of waste are typically either large generators with treatment capability or facilities that specialize only in treatment and/or disposal. Using ArcView Network Analyst, I calculated the road distances of shipments in the sample. The shortest distance was a fraction of a mile, from a generating facility to a neighboring treatment facility, while the longest distance was 2,210 miles, a shipment of chromium, silver, and chloroform waste from Foster City, CA to Baton Rouge, LA. The median distance for shipments was 198 miles (Fig. 5). The mean number of destinations for waste from one facility was just over two miles.

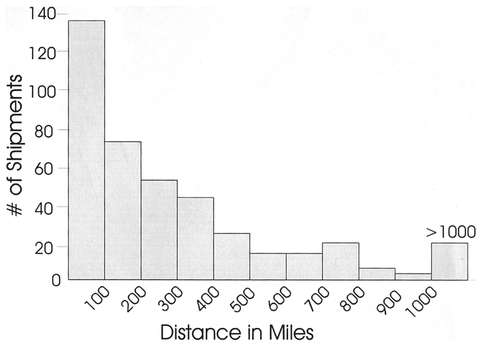

Figure 5: *Number of hazardous waste shipments (<1 ton) vs. distance for sample.*

Companies such as Chemical Waste Management, Clean Harbors, Laidlaw, and Safety-Kleen, the latter two of which have just merged, are prominent in the hazardous waste treatment and disposal business, particularly east of the Rockies. These four companies' facilities were the destination of over one third of the shipments in the sample. They all have a network of specialized facilities, each dominated by one or two treatment or disposal processes, e.g., landfill, incineration, or fuel blending. They collect waste regionally, but then sort and transship most waste for treatment at the appropriate facility.

To further illustrate the shipping patterns of hazardous waste facilities, I chose to examine three generators from the sample from three different regions. The three were chosen because they were "typical," close to the median value for generation (23.6 tons) and for distance of shipments (198 miles), and they were close to the mean for the number of destinations for waste (2.1). Figure 6 uses arrows and text boxes to describe shipments from Kaiser Foundation Hospital in Sacramento, CA, Owens-Corning Fiberglass in Amarillo, TX, and the Massachusetts College of Art in Boston, MA. The pattern of transshipment to specialized facilities within Safety-Kleen is obvious in two examples. Also, proximity is clearly important because only one of nine shipments and transshipments went beyond the one to two state regions where the facilities are located. But every shipment did not go to the nearest

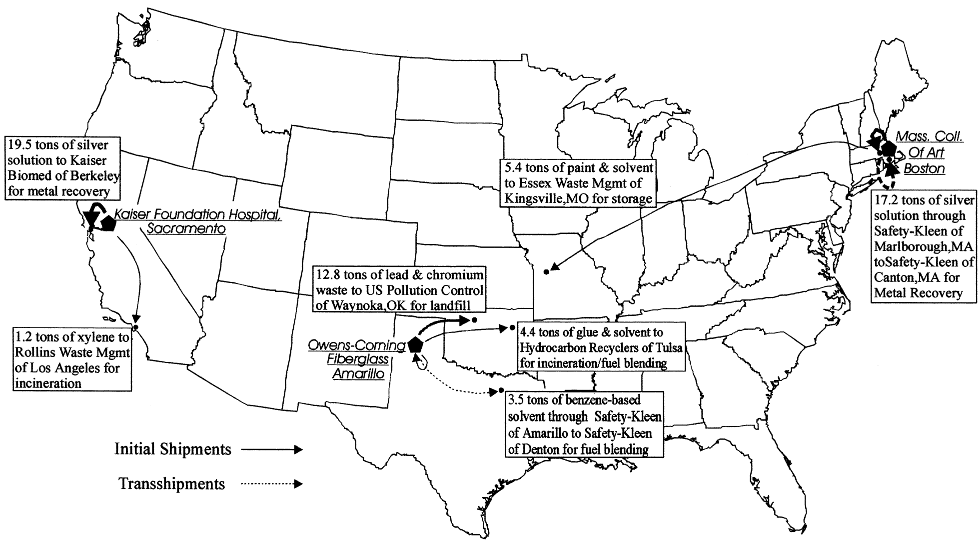

Figure 6: *Destinations, content, and handling methods for hazardous waste shipments from three typical waste generators in three different regions, 1995.*

treatment, storage, and disposal facility (TSDF), so business relationships and the ability of a TSDF to handle a particular waste were also important in the choice of where to send waste.

Releases

Although RCRA mandates that industry carefully track and manage hazardous waste, some hazardous chemicals are still released into the environment each year. The toxics release inventory (TRI) recorded 1.1 million tons of uncontrolled or routine toxic chemical releases to the land, air, and water in the United States in 1995, 71% of which went directly into the air (U.S. EPA 1997a). Comparing the TRI totals with RCRA totals is problematic because chemical concentration requirements vary between the two systems (Code of Federal Regulations 1997, 30–31; U.S. EPA 1997e). However, suggested TRI measurement methods are meant to factor out nonhazardous components of the waste stream such as water (U.S. EPA 1999, 24–6), which RCRA's methods do not. Thus, per unit of weight, TRI totals are likely more concentrated than RCRA's.

Only two of the top 50 hazardous waste generators were also among the top 50 facilities in toxic releases to land, air, and water. Combined, the top 50 hazardous waste generators released 33,400 tons of toxic chemicals, only 3% of the national total, and much less than the 178 million tons of RCRA waste they generated and handled. The remaining 97% was released by smaller generators and facilities not covered by RCRA. Federal and state governments report hazardous waste management as only a low to moderate risk to the host community (Salcedo et al. 1989, 50; California Comparative Risk Project 1994, 22). Nevertheless, hazardous waste facilities remain controversial, often unwelcome neighbors.

Controlling the Location and Movement of Hazardous Waste

Despite the demand for goods with hazardous by-products, state and local governments, and citizens have fought the siting of hazardous waste handlers and generators within their regions. Federal government and industry officials are quick to label such resistance a strain of the broader "NIMBY Syndrome," a pejorative acronym for "not in my backyard," representing the selfishness of consumers who are unwilling to accept a reasonable risk (Portney 1991, 7–14; Dear 1992, 288–90; Lake 1993, 87–9; Meyer 1995, 298–300; Inhaber 1998, 1–12). Some advocates for the environment, such as Greenpeace, counter with NIABY, Not-In-Anyone's-Backyard, the idea that hazardous waste facilities would be unnecessary in a "closed-loop" system that depends on source reduction and nontoxic materials to reduce hazardous waste to practically nothing (Kruszewska and Thorpe 1995).

Local Action

The pressure to site hazardous waste treatment, storage, and disposal facilities (TSDFs) has eased since the late 1980s because of two interrelated factors. First, too many facilities were built after the promulgation of laws like RCRA in the early 1980s. Second, waste quantities have fallen more quickly than anticipated, leaving overcapacity at many TSDFs (Hazardous Waste Consultant 1996, 1.11; *Atlanta Journal-Constitution* 1997). However, local resistance remains for new generators and managers of hazardous waste, such as plants specializing in disposal of PCBs (Brand-Williams 1996; McKee 1997), chemical production plants (*Valdosta Daily Times* 1995; Dawson 1997), even household hazardous waste collection facilities (Bukro 1998). National environmental groups may assist in resisting facilities, but people within a community are more willing to organize, circulate petitions, and speak up at public meetings to protest plans for a *local* plant because these people perceive that their own family or property is threatened. Thus, whether justified or not, the NIMBY label remains.

A strong negative reaction from citizens can convince a company or government agency to move their planned facility to an area of less resistance (Crawford 1996, 41–70; Morell 1996, 157–70). On the other hand, an uncertain economy can lead business leaders, government officials and citizens of some isolated locales to favor the siting of a job-creating chemical plant or even a TSDF in their immediate area, particularly if compensation is involved (Shuff 1988, 51–3; Castle and Munton 1996, 59–62, 66–76). But talk of siting hazardous waste facilities can divide communities between those who feel they would benefit from the project, usually through economic gain, and those who feel they are particularly at risk from the waste. Taking sides in such disputes can highlight a web of divisive issues such as race, economic standing, property rights, and the role of government (Portney 1991, 108–23; Kasperson et al. 1992, 170–83; *Christian Science Monitor* 1996; Crawford 1996).

No response to siting issues has attracted more attention than the environmental justice movement which promotes the right of poor and/or minority communities, as well as the more affluent, to control their fate with regard to hazardous waste facilities. Many who have studied the issue in depth have shown a relationship between the location of minority populations and hazardous waste facilities, and the targeting of these communities because of their demographics (United Church of Christ Commission for Racial Justice 1987; *San Francisco Chronicle* 1991; Bryant and Mohai 1992; Burke 1993; Bullard 1994). Others, in studies partially funded by the industry, argue for no conclusive link between TSDFs and minorities (Anderton et al. 1994; Oakes et al. 1996). Still others have shown that minority-hazard link is seen at broad scales but is less obvious at a finer scale (Bowen et al. 1995).

Congress has become concerned with the local impact of hazardous waste facilities. Two bills to prohibit the location of TSDFs near residences, day care centers, parks, etc., H.R. 843 and H.R. 1199, were introduced during 1997 (*Congressional Record* 1997). While these bills have not made it out of committee, they do indicate the political popularity of efforts to control siting of waste facilities.

State and International Controls

The spirit of NIMBY echoes across broader political scales, as "not in my state" or "not in my country." Internationally, the Basel Convention, first signed in 1989, was amended in 1995 to ban the export of hazardous wastes from Organization for Economic Cooperation and Development (OECD) countries (mostly industrialized countries) to non-OECD members (Hilz, 1992; Sinding 1996, 801–8). Efforts to stem the flow of hazardous waste within the United States have proven more problematic. State legislatures acted to restrict the importation of hazardous waste, or to discourage its disposal within their boundaries, but little of the legislation has survived legal challenge.

The landmark decision on interstate movement of hazardous waste is from the 1978 case of City of Philadelphia v. New Jersey. In 1978, New Jersey enacted a law which read in part, "No person shall bring into this state any solid or liquid waste which originated or was collected outside the territorial limits of the state (exceptions at judgement of commissioner of State Department of Environmental Protection)" (quoted in Urie 1995, 358). As applied, the law prohibited out-of-state waste from entering New Jersey. The U.S. Supreme Court ruled the law unconstitutional, citing the Commerce Clause of the U.S. Constitution which states that, "the Congress shall have power . . . to regulate Commerce . . . among the several states . . ." (U.S. Constitution, Article 1). Waste was ruled an article of commerce, not a material which, "would bring in and spread disease, pestilence and death" (U.S. Supreme Court 1888) as the New Jersey Supreme Court had argued in an earlier decision upholding the law.

The City of Philadelphia v. New Jersey decision has since dissuaded efforts to block or limit out-of-state waste, but in 1989, and again in 1990, the Alabama State Legislature targeted the Chemical Waste Management, Inc. (CWM) facility at Emelle, AL, the largest such facility in the United States. This TSDF landfilled 788,000 tons of hazardous waste in 1989, 91.4% of which came from outside Alabama. In 1989, the legislature passed a law blocking most out-of-state waste, but it was challenged by CWM and ruled unconstitutional by a federal appeals court, citing the City of Philadelphia case. Undaunted, in 1990 Alabama adopted a surcharge on out-of-state hazardous waste which was also challenged by CWM and was struck down by the Supreme Court (Alabama Code of Regulations 1990; U.S. Supreme Court 1992; Urie 1995, 362–3). Similar surcharge laws have more recently been struck down in Oregon and in South Carolina.

The Commerce Clause would likely allow state-owned TSDFs to tax shipments of waste from other states (Urie 1995, 376–7). But such a tax would be irrelevant if other commercial TSDFs were still importing waste at a lower rate. Moreover, no large state-run facilities currently exist in the United States.

More subtle legislation has successfully limited the import of toxics to some states. The most common method is a tax on all waste treated or disposed of in a state, regardless of origin. For instance, in California a tax of $110 per ton for all hazardous waste both discouraged hazardous waste importation and encouraged waste treatment and disposal outside California (California Code of Regulations 1996). In 1995, California exported 1,082,408 tons of RCRA hazardous waste while importing only 73,792 tons (U.S. EPA 1997c, 69). Likewise, longitudinal national studies found that high taxes on hazardous waste treatment or disposal significantly discourage importation of hazardous waste (Reams et al. 1993, 100–3; Levinson 1997, 27).

Four states stand out in Figure 7, a map showing the difference between hazardous waste imports and exports for each state. California was the leader in net exports while New Jersey, Michigan, and Nevada led in net imports. In these four states, a small number of facilities were responsible for the bulk of activity in shipping and receiving waste. Of California's over 1,000,000 tons of exports, Chemical Waste Management of Azusa, a regional collection center for southern California, was responsible for over 900,000 tons, mostly to large plants in Texas and Louisiana. The bulk of Nevada's imports came from one out-of-state generator to US Ecology in Beatty. Most of Michigan's total came from a single facility in Canada to Systech Environmental Corporation in Alpena, and the majority of New Jersey's imported waste came from three oil refineries in Pennsylvania to Republic Environmental Recycling in Clayton. Both Systech and Republic are large facilities that were originally sited where they are because of the considerable waste generated within Michigan and New Jersey, but waste is mobile, and benefiting from the court's interpretation of the Commerce Clause, these companies have been able to develop large out-of-state customers. For the 95% of generators who do not treat waste on site, exporting waste over state borders is important, especially for those from small states with few TSDFs and for those who produce special wastes that can only be handled by one or two facilities in the U.S. (MacMillan 1993, 31–4).

Conclusion

Large quantity generators in the United States produced 214 million tons of hazardous waste during 1995, the vast majority of which was wastewater. Over 80% of this total was gener-

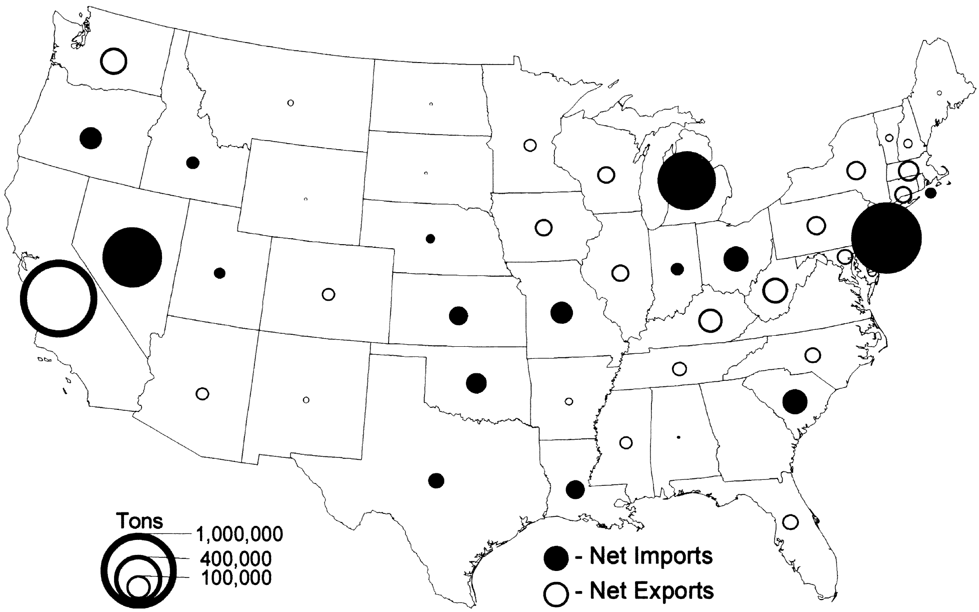

Figure 7: *Differences between imports and exports of hazardous waste (net imports/exports) by state, 1995.*

ated by the largest 50 generators in the country, most of whom are petroleum or petrochemical plants located along the Gulf Coast of Texas and Louisiana. This regional concentration can be explained by a favorable combination of geology, politics, culture, economics, and history. The small number of massive plants generating so much waste is due to the need for economies of scale in raw materials, equipment, and technical and management expertise in petroleum-based industries. These industries not only create huge amounts of hazardous waste; they are among the most successful exporters of American goods.

Most of the hazardous waste produced in the United States is treated at the same facility where it was generated, particularly at the largest facilities. Thousands of smaller generators, however, are more likely to ship their waste over highways and railroads to large, specialized TSDFs, also driven by economies of scale. Generally, neither generators nor TSDFs are welcome neighbors, and local resistance to them continues around the country. Moreover, as waste moves through large, multi-facility waste companies, such shipments often cross state borders, creating a perception of inequality, that another state gains wealth by manufacturing, and one's own state becomes their dumping ground. State legislatures have attempted to solve this perceived inequality with restrictions on or extra taxes levied on hazardous waste originating outside their boundaries. But each time federal courts have struck down the laws, citing the Commerce Clause of the U.S. Constitution. On the other hand, high fees on all hazardous waste treated or disposed of in a state have been judged constitutional. These fees appear to reduce imports and increase exports of hazardous waste, partially controlling the location and flow of hazardous waste. ■

Note

[1] Radioactive waste is regulated by the U.S. Nuclear Regulatory Commission and by the states. Mining wastes and oil and gas drilling wastes were exempted from the tight regulations of the Resource Conservation and Recovery Act (RCRA) Subtitle C (Hazardous Waste). They are regulated by the less stringent Subtitle D (Solid Waste) rules and by the laws of individual states. 361 million barrels of drilling waste was generated in the United States in 1985 (U.S. EPA 1987).

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