Environmental Implications of New Mexican Industrial Investment: The Rise of Asian Origin Maquiladoras As Generators of Hazardous Waste[1]

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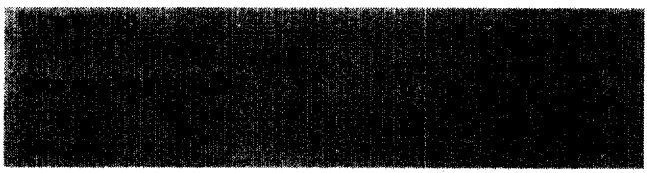

Introduction

Export processing zones (EPZs) are widely recognized as strategic sites for globalization (Sassen, 1998: 392). Mexico's northern border was designated as an EPZ in 1966, allowing foreign owned companies to import supplies and machinery duty free for processing in maquiladoras, and then export the products paying taxes on only the value added. In the almost forty years since their inception, maquila growth has transformed Mexico's northern border and become one of the country's main links to foreign markets. This is part of the world wide expansion of export processing and

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reformation of capitalism, whereby an increase in the production of salable products has been accompanied by a commensurate rise in the waste inherent in processing. "The steady diffusion of industrial modes of production from North to South—a form of globalization—has led to a massive increase in the total capacity of the global economy to generate environmental pollutants that threaten the global commons, such as seas and the atmosphere." (Held et al., 1999: 380) This is especially true of Mexico's maquiladoras, since most of them are in communities without much industrial history, and without adequate facilities to properly manage, handle or treat industrial waste. Despite maquiladoras' contribution of exports and jobs to Mexico's crisis ridden economy, they are not without their contradictions, one of which is that export-led development thrives in environmentally unsustainable conditions, an``d may threaten the ecological survival of its host community (Sklair, 2000).

This paper is by necessity exploratory because very little is actually known about industrial hazardous waste at Mexico's northern border. Mexico only began to pass laws regulating industrial waste in the late eighties as a result of public pressure during NAFTA debates, and has not yet been able to invest as much as needed in their implementation. This means that the records regarding industrial waste are not comprehensive, although data are now beginning to be collected more systematically. The situation varies tremendously throughout Mexico. Many of the records that do exist are made up of estimates and not exact measurements of hazardous wastes. For example, hazardous wastes are imported into Mexico as raw materials, and maquila plants estimate how much they import when they report it to the authorities which are officially charged with keeping track, the *Secretería de Medio Ambiente y Recursos Naturales* (SEMARNAT, formerly SEMARNAP). Until 1994, there was no inventory of hazardous waste in Mexico, which means that there was no way of knowing how much hazardous waste was produced where—a fact that is sometimes difficult for observers from more developed societies to comprehend. Another source of information is the U.S. Environmental Protection Agency's Haztraks data base, which contains information on generators of hazardous waste shipped

from Mexico to the United States from 1986 to 1999. The latter measures wastes more accurately than the former, but does not include wastes generated in Mexico that are not imported to the United States.

We use both of these data sources, as well as other supplementary ones, to examine some aspects of transboundary pollution, which is "the transmission of pollutants through the media of air, soil and water from their point of generation or creation across political borders so that their environmentally degrading impact occurs in other legal jurisdictions." Because of data limitations, the paper focuses on "transboundary movements of pollutants that are the immediate, intended and often legal result of economic exchange and production [as in] the movement and relocation of highly polluting industrial plants." (Held et al.,1999: 380, 381) Where information is available, some cases of illegal environmental degradation are also considered, such as companies which have been closed and/or fined for violating Mexio's environmental laws.

This paper explores the hypothesis that national origin of maquiladora investment has had an impact on where in northern Mexico the greatest quantity of legally reported hazardous waste is generated. Between 1996 and 2000, 70% of all private investment in Baja California Norte was of Asian origin, and only 15% came from the US (Mungaray, 2001:18). We suggest that the increase in Asian origin maquiladora investment in the last half of the nineties has profoundly changed which maquiladora centers host the greatest generators of hazardous waste. We look at how the diffusion of production from the north to the south, as well as relocation of industry from the west to the east, has brought an unprecedented increase in the amount of hazardous waste generated in northern Mexico, and suggest ways in which this newly industrializing society might reduce and avoid the inherent risks.

Review of Relevant Literature

Although the electronic industries concentrated here have the image of

being relatively clean, they require chemical raw materials for production which are hazardous and require special treatment. Carrillo (1986) documented the under-reporting of illnesses among electronic workers due to their handling of toxic substances in Tijuana industries and Sánchez (1990) described some little known negative aspects of the generation of dangerous waste and the handling of dangerous materials in Mexicali industries. Montalvo (1992) studied 6 Tijuana plants making printed integrated circuits in Tijuana to test for the existence of an external economy in which hidden costs were incurred that remained unpaid. He modeled how high the costs of treatment and confinement of waste would be if they were to be paid. Mercado (1999) has investigated the extent to which the provision of economic incentives might stimulate border industries to better treat and dispose of hazardous industrial waste.

Despite the lack of information, more was learned about the environmental implications of industrial development in the nineties than before. The *Secretaría de Desarrollo Social* and the *Instituto Nacional de Ecología* (SEDESOL-INE) suggested that for 1991, the maquiladora industry was the greatest generator of hazardous waste at the northern border. Approximately 30 percent of border companies generating hazardous waste (almost all of which were maquiladoras) sent 32,707 tons per year to the United States. Only 5.4 percent of companies disposed of waste in Mexico, for a total of 16,054 tons per year.[2] For the two decades preceding 1992, only 2,000 industry inspections were carried out. However, between 1992 and 1996, there were from 10,000 to 20,000 annual inspections.

The year 1992 was a turning point, when the Federal Prosecutor for Environmental Protection (PROFEPA) began operations. Between 1992 and 1996, PROFEPA reported three sites where hazardous waste had been abandoned, one in Ciudad Juárez and two in Tijuana. The latter were the companies *Alco Pacifico* and *Metales y Derivados*.[3] Antonio Sandóval, the Baja California representative of PROFEPA, said in August, 1996 that his

[2] SEDESOL-INE. Residuos peligrosos en el mundo y en México. P. 119.
[3] Statement of José Luis Calderón. *El Mexicano (Tijuana)*. June 28, 1996.

office had carried out 628 inspections so far that year, 255 in Mexicali, 184 in Tijuana, 110 in Tecate and 79 in Ensenada. As a result, there were 8 companies permanently closed, of which 6 were in Mexicali, 1 in Ensenada and 1 in Tijuana. There were also 11 temporary or partial closures, 9 of which were in Mexicali and 2 in Tijuana.[4]

While there has been progress since 1992, it can be easily undone. Researchers have documented how some industries closed in Tijuana and Nogales for violating environmental laws have been reopened without solving the problems which led to their closure (Montalvo, 1992; Cravey, 1998). A fire at the plant owned by Pacific Treatment in Tijuana in July, 1997 was also a sobering message of how much still needs to be done, as it consumed approximately 200 tons of toxic waste (paint, solvents, thinners) and sent clouds of noxious fumes over residential areas and contaminated run off into the Pacific Ocean.

The capacity to safely manage hazardous industrial waste has not yet been developed in Mexico. In 1994 there was infrastructure to manage 1.10 tons and in 1996, 1.15 tons. From 1994 to 1996, Mexico had services to dispose of 26% of the 8 million tons of hazardous industrial waste generated that year.[5] It was estimated in 1996 that Mexico could only control about 12% of the hazardous wastes generated with the infrastructure and services available (Carabias, 1996). Between 1995 and 1996 the maquiladora industry exported 77,000 tons of hazardous industrial waste to Finland, England, France and Holland.

The type of hazardous waste generated at the northern border adjacent to the United States varies, but some patterns can be discerned. In 1995, almost half was solvents, oils, and grease. These have a liquid or semi liquid form, or are mixed with waste water discharges. In the catchment area of the Tijuana River, an estimated 30,000 tons of hazardous waste were produced in 1997, 12,000 tons of which were returned to the United States. The whereabouts of the other 18,000 tons generated by local industry is unknown (Reyes and García: 1997). Hazardous waste exported from

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[4] Statement of Antonio Sandoval in *El Mexicano (Tijuana.*, August 27, 1996.
[5] *Theorema*. No. 13. June-August, 1997.

Mexico to the United States via the Otay Mesa customs post in Tijuana includes the following: lead sludge from water treatment plants, paint sludge, cloths impregnated with thinner and paint, waste shellac and sealer, contaminated towels, nickel sludge, and empty paint containers (Fernández Willborn: 1999). As Ganster (1997: 254) has argued:

> Largely because of the lack of infrastructure and regulatory and enforcement capacities in the border region, particularly in Mexico, only a small percentage of hazardous waste from border maquilas is being disposed of in a fashion that would meet generally accepted international standards. The rest is being stored (often improperly), dumped in municipal landfills, or discharged into the wastewater collector system. Some individuals and groups have taken advantage of the border illegally to transport and dump hazardous materials on the Mexican side.

Solvents used in the electronics and heavy metals associated with metal finishing operations seem to be the most common problems.

New institutions created as a result of NAFTA have served to bring some of the problems noted in the previous studies into clearer view. However, researchers continue to find that the investment and jobs created in the maquila sector have an "environmental price" and that "the industry's production of industrial waste has outstripped its disposal capacity."[6] According to a report published by the INE in 1997, random disposal of toxic waste from Mexican industry has created serious contamination problems for 38 metropolitan areas and 27 states in Mexico.[7] At the northern border, problems with the random disposal of hazardous industrial waste were attributed directly to the maquiladora industry, especially in Nuevo Laredo, Piedras Negras, Nogales, and Mexicali.

Antonio Sandóval, the Baja California representative of PROFEPA, said in January, 1998, that the sewage generated by the maquiladora industry represented the most serious contamination problem in Tijuana and that

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[6] Report by researchers at El Colegio de Mexico cited in Nick Wilson, "Maquiladora: 20 Percent of Industrial Labor" *El Financiero International*. January 20-26, 1997. 6 (31): 4.

[7] *SourceMex*, 8 (30), August 20, 1997. "Report Says Arbitrary Disposal of Hazardous Material Causes Major Problems In 38 Cities and 27 States"

finding a solution was one of his office's highest priorities.[8] During 1997 more than 2,200 companies were fined over 2,117,000 pesos for generating contaminants that did not meet the legal standards for proper handling. He announced that 300 inspections would be carried out in 1998 in Tijuana's industries and hospitals, 100 in Tecate, 100 in Ensenada, and 388 in Mexicali. This is a sizable increase in the number of inspections in comparison to those done in 1996, noted above. In the meantime, because there is no pre-treatment of sewage in Tijuana, tests at the South Bay International Wastewater Treatment Plant (SBWTP) at the end of 1997 showed chronic toxicity with dioxins exceeding the plant's permit limits on several occasions. Saldaña (1998) concluded that many of these toxins end up in the soil in the Tijuana River Valley and the United States: "These tests indicate that the discharge from this plant will, in fact, endanger marine life, and possibly create a public health risk."

Data and Methodology

Data on the hazardous waste exchanged between the United States and Mexico are gathered from U.S. hazardous waste manifests, U.S. treatment, storage and disposal facility notifications of intent to receive hazardous waste, Mexican *guías ecológicas*, and made publicly available in summary form.[9] The summarized data made available by the EPA show the top ten factories generating hazardous wastes shipped to the United States from each Mexican border city in 1996 and 1997. In 2001, the EPA had codified plant level information on hazardous waste imported to the United States from 1986 to 1999, facilitating more long term and detailed analysis which begins in this paper.

By Mexican law, industries must report twice annually the hazardous waste they generate to the *Secretaría de Medio Ambiente, Recursos Natuales y Pesca* (SEMARNAP, now SEMARNAT), which in turn sends

[8] *El Sol de Tijuana*. 1998. "Aguas Residuales Generadas por Industrias, Prioridad de PROFEPA" 29 de enero: A3, A6.

the data to the *Instituto Nacional de Ecología* (INE) in Mexico City and to the EPA in the United States. Data were collected from SEMARNAP in Tijuana in 1998 on the type and quantity of hazardous waste generated by Baja California Norte's industries. The Tijuana office received the information in hard copy from plants, then stamped it as received and filed it in a box. The Tijuana office recorded some data for the author from these hard copies for 1998, which took approximately one year of part time work by several people. This study is unique in being the first to have access to such data, although it is not without its drawbacks as noted below.

The data base begun at Tijuana's SEMARNAP division lists plant name and waste generated in kilograms for the following substances: spent oils, pitch or tar, heavy metal slag, liquid waste, sludge, solids, spent solvents, and corrosive substances. More variables were added to this data base for the purposes of analysis by the author. First, plants legally registered as maquiladoras were identified and distinguished from those which were not. The latter were considered to be *industria de transformación*, or domestic manufacturing. The author then integrated these data with previous work done to map the location of plants by sector, size, etc. (Kopinak, forthcoming). With information about the product produced in each plant, it was then possible to code the type of danger that the hazardous waste presented in terms of its corrosivity, reactivity, explosive potential, toxicity, ignitability, and biological infectiousness (CRETIB).

An index of risk was developed which reflected environmental danger, workplace risk, health, and response factors. The index is comprised of four separate criteria, which are summarized in Table 1. The environmental risk criteria are those which are deemed hazardous under Mexican law (see NOM-053-ECOL/93): corrosive, reactive, explosive, toxic, inflammable and biologically infectiousness (CRETIB). Risk at work is defined under Mexican law (see NOM-010-STPS-1994 y NOM-114-STPS/1994) as particular threats to safety and health in the work place, and includes the specification of the concentration of particular substances which are dangerous to the worker's health and safety in the long term, short term, or

[9] http://www.epa.gov/earth1r6/6en/h/haztraks/haztraks.htm

for any amount of time at all. The third criteria evaluates whether the results of exposure on health might be short term acute, long term acute, medium term chronic, or long term chronic effects. The final criteria is the type of risk introduced by the possible reactions to emergency exposure-- whether a rapid and efficient response is likely, an efficient but slow response, a slow and inefficient response, or a very slow and inefficient response.[10] Each of these criteria were taken into account in evaluating the productive process at a plant and deciding on a level of risk that would reflect all four factors.

This index has four categories--minimal, moderate, high, very high--which were used to code all SEMARNAP reports made in 1998, and EPA data on the top ten generators of hazardous waste in Tijuana from 1986-1999. A hazardous waste report was assessed as having minimal risk, for example, if it had only one danger (out of the 5 possible CRETIB), a low level of concentration in the workplace, acute short term effects on health caused by exposure, and a rapid and efficient response in case of emergency. The risk index was assessed as very high if there were 5 or more dangers (of the 5 possible CRETIB), a very high concentration in the workplace, chronic long term effects on health that is caused by exposure, and a slow and inefficient response in case of emergency.

The index of risk assumes that all hazardous wastes are handled properly and according to the law. It does not include any consideration of hazardous wastes that are handled improperly, such as liquids or solvents from a production process that go down the drain, which does happen given the measurements taken at the water treatment plant reported above. Another possible source of inaccuracy with SEMARNAP data is that they are not verified, so that there is no assurance that companies are reporting the truth. For these reason and others, the index is an underestimation. Additional data came from an in depth interview with a manager of a recycling company, another with staff at a workers' education center, and a visit to one of the biggest generators of hazardous waste.

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[10] This was adopted from the 1996 *Guia Norteamericana De Respuesta En Caso De Emergencia*, published by the U.S. Transportation Department, Transport Canada, and the

Table 1. Indicators of Risk Used to Construct the Index of Risk

	Environmental Risk	Workplace Risk	Health Risk	Response Risk
Levels	CRETIB Criteria [1]	CPT, CCT, P [2]	DL_{50} CL_{50} [3]	ID, Safety, Hazards, Actions [4]
Minimal	1 Criterion	Low Level	Acute short term effects	Rapid and efficient response
Moderate	2-3 Criteria	Moderate Level	Acute long term effects	Slow but efficient response
High	4 Criteria	High Level	Chronic medium term effects	Slow and inefficient response
Very High	5 or more Criteria	Very High Level	Chronic long term effects plazo	Very slow and inefficient response

[1] Corrosive, Reactive, Explosive, Toxic, Inflammable, Biologically Infectious (NOM-052-ECOL/93)
[2] Weighted average concentration over time (CPT), Concentration for short term exposure (CCT), and Peak Concentration (P) which is the concentration that should not be exceeded at any time in the work place.(NOM-010-STPS-1994)
[3]NOM-114-STPS/1994
[4] Guía Norteamericana de Respuesta en Caso de Emergencia, 1996.

Findings

(i) Changes in Location of Greatest Hazardous Waste Generators over Time:

In order to test the hypothesis that the location where hazardous waste was generated in northern Mexico has changed over time with new investment in maquiladoras, the top ten generators of hazardous waste were selected from the Haztraks data base for all available years. The results show that the top ten generators are repeatedly located in only a few *municipios*, especially Matamoros, Ciudad Juárez, Mexicali, Tijuana, and some communities in between (See Table 2). Looking at the total hazardous waste generated in each *municipio* for all years, the greatest amount (15,225.5 U.S. tons) came from Tijuana, while Cd. Juárez was the location

Secretaria de Comunicaciones y Transportes.

of second highest generation (13,766 U.S. tons). However, there is a clear change in the generation of hazardous waste, with the biggest generators being at the eastern end and center of the border in the early period, but then appearing at the western end of the border in later years. This spatio-temporal transformation is accompanied by more than a tripling in the quantity of hazardous waste generated. The total quantity of hazardous waste generated in the Baja California *municipios* of Tijuana and Mexicali, as well as the adjoining community of San Luis R.C. (15,225.5 + 5,209 = 20,043.5 U.S. tons) is 3.3 times as much as the total quantity of hazardous waste generated at the eastern end of the border in Matamoros, Reynosa, Nuevo Laredo, and some *municipios* in Nuevo León (2,827 + 3,157 = 5,984 U.S. tons).

Table 2. Total Hazardous Waste Shipped from Mexico to the U.S by Top 10 Mexican Generators for *Municipios*: 1986 to 1999 (U.S. Tons)

Year	Matamoros	Reynosa NLaredo N. Leon	Juárez Chihuahua	Nogales Son. Zapopan, Jal.	Mexicali S. Luis RC	Tijuana	Total
1986	*	*	18	*	*	0.5	18.5
1987	9	65	305	*	*	*	398
1988	*	264	322	36	*	*	602
1989	51	67	372	*	*	*	490
1990	120	*	749	*	65	*	1031
1991	505	*	801	*	195	1180	3145
1992	731	153	1020	*	179	1335	3658
1993	270	216	2697	*	*0	1703	4882
1994	301	1598	2532	248	*	2299	6979
1995	204	579	1563	*	404	752	3503
1996	264	*	1403	148	394	615	2795
1997	256	*	1070	*	714	3517	5724
1998	116	215	832	103	510	1258	3035
1999	*	*	582	*	2748	2566	5896
Total	2827	3157	14266	535	5209	15225.5	42156.5

* Asterisks indicate that a *municipio* did not have any plants in the top 10 generators for that year. However, hazardous waste may have been generated there which was not great enough to make the top 10.

Note that the horizontal axis lists *municipios* from the east to the west.

Source: U.S. Environmental Protection Agency. 2001. *Haztraks*. San Francisco, CA.

(ii) National Origin of Greatest Hazardous Waste Generators

To test the hypothesis about the national origin of the top 10 generators of hazardous waste, we examine the origin of capital of all companies appearing in the top ten for each year. National origin of capital for all companies in the top 10 is the United States from 1986 until 1996 when the first top 10 generator of Asian origin appears. Asian origin generators appear more frequently in the three remaining years for which data are available. (See Table 3 where locations are listed from the east, at the top of the table, to the west at the bottom of the table) These are plants located in Mexicali and Tijuana, and their owners are from South Korea, Japan, and Taiwan. They generate greater quantities of hazardous waste than non-Asian generators. Looking at hazardous waste generated by the top 10 from 1996 to 1999, it is clear that the growth of Asian origin maquiladoras in Mexicali and Tijuana is responsible for those communities becoming the site of the greatest generators of hazardous waste. One company, Samsung Display Mexicana, has been responsible for exporting more hazardous waste from Mexico to the United States in these four years (4,561 U.S. tons) than any other company, and also a greater amount than was exported by all companies in 1996 (2,772 U.S. tons) and 1998 (3,031 U.S. tons). TEPSA (*Transportes Ecológica del Pacifico*) is an alias for PTES (*Pacific Treatment and Environmental Services*), a waste handling company which is hired by many maquilas to transport their hazardous waste. Although the company has its head office in the United States, it transports waste for many different maquiladoras.

Table 3. Top 10 Maquila Generators of Hazardous Waste Shipped to the U.S. from 1996 to 1999.

Generator	Location	1996	1997	1998	1999	Total	Size	Origin	Product
Deltronics de Matam.	Matamoros	137	256	0	0	393	2479	USA	Ignitions, PC Bds.
Comp. Mecanicos	Matamoros	127	0	116	0	243	2479	USA	Air bags auto parts
Kemet De Mexico	Nvo. Leon	0	0	215	0	215	2400	USA	Elect. capacitors
Eaton Molded Prdcts	Cd. Juárez	0	0	131	0	131	600	USA	Golf club shafts
Coclisa (Omega)	Cd. Juárez	445	0	0	0	445	2200	USA	Auto radiators
Delmex de Juárez	Cd. Juárez	394	310	317	347	1368	950	USA	Auto antennas
Diesel Recon 1 & 2	Cd. Juárez	431	411	384	236	1462	5800	USA	Fuel systems
RCA/ Thompson TVs	Cd. Juárez	133	351	0	0	484	5200	USA	TV components
Motores Electricos	Cd. Juárez	126	0	0	0	126	300	USA	Electric motors
Outboard Marine	Cd. Juárez	0	139	0	0	139	600	USA	Outboard Motors
United Tecnologia	Cd. Juárez	0	0	99	0	99	3900	USA	Auto harnesses
Price Pfister de Mex.	Mexicali	364	714	207	504	1741	1203	USA	Polishes faucets
Daewoo Orion	Mexicali	0	0	304	1400	1704	900	S.Korea	Monitors
Melco Display	Mexicali	0	0	0	843	843	1500	Japan	Monitors
Samsung Display	Tijuana	468	2465	1104	524	4561	1300	S.Korea	Display devices
Matsushita Ind.&Batt.	Tijuana	148	0	0	229	377	3967	Japan	TV parts, batteries
Merry Tech Int.	Tijuana	0	751	0	0	751	500	Taiwan	Fans
Am. Optic. Lens-Mex	Tijuana	0	150	0	0	151	850	USA	Plastic lenses
TEPSA/ PTES	Tijuana	0	0	154	485	639	n.d.	USA	Waste handling
Sanyo Manufacturing	Tijuana	0	0	0	1038	1038	4180	Japan	Video components
ERTL de México	Tijuana	0	151	0	0	0	173	USA	Plastic Toys
Total		2772	5698	3031	5896	16880	42181		

All years are reported in US tons, and the date range is Jan. 1 to Dec. 31.
Size is indicated by number of employees.
Sources: U.S. Environmental Protection Agency. 2001. *Haztraks*. San Francisco, CA.
Solunet. *The Complete Twin Plant Guide*. El Paso, TX. (Various years: 1995, 1998, 1999).

The first reason that firms with capital originating in east Asia take on such prominence in the data from 1996-1999 is the fact that they do generate more hazardous waste. This was elaborated in an interview with a recycling company manager. *Ingeniero* Verera of NELMEX said that in 1992 and 1993, their business consisted mainly of thinners, rags and filters from the furniture industry. By 1998, however, televisions and computer assemblers were bigger clients and generated glass tubes with a high lead content. He said that Samsung alone produces more than 10 tons a day of waste via its water treatment plant which is part of its manufacturing process. Metal polishers also became important clients generating hazardous waste in 1998, especially the polishing and sandblasting of metal rims of wheels and golf clubs. Metal polishing processes produce dust, abrasives, and sand. He estimated that 60 tons of these materials were produced per week. Important wastes come from scrap in the form of plastics, sawdust, TV screens, ceramics, rags, rags soaked in solvents which can be washed or incinerated, rags impregnated with oil which can be washed or buried, secondary metals, paint applied in stalls (filters, water curtains), waste sludge from treatment plants, waste platinum metal, and even greater amounts of solvents.[11]

We suggest that there are also intervening variables affecting the reporting, although not necessarily the generation, of hazardous waste, such as (i) size of firm, (ii) second or third generation capabilities, and (iii) completing a paper trail. Larger firms tend to have more complete administrative departments and more resources for reporting. As Table 3 shows, Asian origin plants have many more workers, on average, than U.S. origin plants. The idea that three generations of maquiladoras have emerged, doing assembly, manufacturing, and design, has been suggested by Carrillo and Hualde (1998). Firms which go beyond assembly, such as Samsung which also manufactures, and Sony which also designs, have more complete operations in Mexico and therefore probably more resources for reporting. Although size and generation are considered to be intervening variables

[11] Interview with *Inginiero* Eduardo Vereo de *Nueva Exportadora Latina de México (NELMEX)*, S.A. DeC.V., October 21, 1998.

between the independent variable of national origin of capital and the dependent variable of reporting hazardous waste, they interact with and are more related to the Asian origin of capital, the independent variable. Mexican maquiladora centers were originally labour intensive cost reduction operations, and most U.S. owned plants still have this emphasis. The Asian owned plants also transfer the last parts of the production process to Mexico, but they are more likely to combine labour intensive work with more sophisticated technologies because their strategy is to penetrate the U.S. market from Mexico (Barajas, 1989). This is why it is the east Asian owned maquiladoras that have made Tijuana the 'TV capital of the world' in the last dozen years.

A third reason that Asian origin firms are over-represented among plants reporting the generation of hazardous waste is that they may be continuing a paper trail which had a previous step of registering hazardous waste when it entered the United States. Maquiladoras in general import 98 percent of hazardous and non-hazardous inputs, and Alegría (1992) has suggested that they are likely to import inputs from the same location as the head office. Even though Asian based maquiladoras have been convincing more of their suppliers to relocate to North America, there is still a great shortage of North American produced supplies in industries in which Asian based capital specializes. Mitusuharu Nakata, the vice president of the Japanese Maquiladora Association in Tijuana, complained that Mexico had no industrial policy to stimulate supplier development, noting that of all the televisions produced in the area, only 4% of the 750 required components were produced in NAFTA countries.[12] Hazardous supplies imported from Asian countries by Tijuana maquiladoras probably enter the continent at Long Beach, California where they then become the property of the U.S. head office of the Asian origin company, legally defined as an American firm. They are then exported to Mexico under maquiladora rules. Although there was a belief on the part of many that hazardous wastes imported to Mexico would be allowed to remain in Mexico after 2000, Mexico did not in fact change its law requiring that all hazardous waste imported by

[12] Rosa Arce. 2000. Preocupan altos costos. *Frontera* (Tijuana). 11 de octubre.

maquiladoras be either properly treated so it is no longer hazardous, or exported back to the country of origin. In the case of Asian origin firms, the country or origin from Mexico's point of view would be the United States, since hazardous materials from outside North America would be considered American if they passed through the United States before entering Mexico to be processed by maquiladoras.

(iii) Risk Level of Hazardous Waste Reported in Tijuana:

We turn now to a more in depth look at hazardous waste generated in Tijuana and Mexicali and passing through Tijuana. After coding all plants which reported having generated hazardous waste in 1998 to SEMARNAP by level of risk, and dividing them into maquiladora and non-maquiladora regimes, the results inidicate that those generators which were not maquiladoras were responsible for only a very small quantity, 4% of all kilograms (946,500/23,590,219) and 8% of all reports. (See Table 4) Moreover, 92% (872,538/946,500) of their hazardous waste is at the minimal risk level. Maquiladoras generate all of the hazardous waste coded as having very high risk, 98% (1,128,513/1,150,194) at the high level, almost all at the moderate level, and 91% at the minimal level. While Tijuana is one of the few Mexican cities along the northern border that has a history of domestic manufacturing, it is clear from this evidence that the maquiladoras are the ones generating the greatest quantity and the riskiest hazardous waste.

Table 4. Level of Risk of Tijuana Hazardous Waste By Plant's Industrial Regime in 1998

	Maquiladora		Non-maquiladora		Total	
Risk Level	Reports	Kilograms	Reports	Kilograms	Reports	Kilograms
Minimal	110	8,721,988	22	872,538	132	9,561,432
Moderate	157	11,499,321	2	52,381	159	11,551,702
High	36	1,128,513	4	21,581	40	1,150,094
Very High	17	1,326,991	0	0	17	1,326,991
Total	320	22,676,813	28	946,500	348	23,590,219

Sources: SEMARNAP, Tijuana, B.C. (1998) and US EPA. *Haztraks*. (2001)

Table 5 shows the top ten maquiladora generators of hazardous waste which passed through the Otay Mesa customs post in Tijuana from 1996 to 1999, in comparison to the earlier findings on the top ten which were for all of Mexico. Some of the quantities shipped may be different in this table than in Table 3 because Table 5 only considers what passed into the United States through Otay Mesa, and not other customs posts. Over half of the plants in the top ten and 82% of the hazardous waste generated come from Asian origin plants. South Korean owned plants generated the most (5,611 U.S. tons), Japanese owned plants are second (2,607 U.S. tons), and Taiwanese the third (936 U.S. tons). Once again, Samsung Display Mexicana is the largest hazardous waste generator by far over any other company, responsible for 37% of the total quantity for all four years. There is also a similar relationship to risk level, with east Asian origin, and particularly South Korean owned plants generating the riskiest hazardous waste.

Table 5: Top Ten Maquiladora Generators of Hazardous Waste Shipped to the U.S. Via Otay Mesa Customs Post in Tijuana, B. C.: 1996-1999 (U.S. Tons)

Generator	1996	1997	1998	1999	Total	Risk	Origin	Size
Samsung Display	452	2405	881	524	4262	V. High	S. Korea	2000
Daewoo Elect. & Orion	*	*	294	1052	1346	V. High	S. Korea	2900
Sanyo Mfg. & S.I.A.	*	91	*	1038	1129	V. High, High, Moderate	Japan	5580
Merry Tech	*	751	*	*	751	High.	Taiwan	500
Melco Display				711	711	V. High	Japan	200
Matsushita Batt & Ind.	148	201	75	229	653	Moderate	Japan	3967
PTES/TEP SA	*	*	137	462	599	n.d	USA	n.d.

Pulidos I & II	*	*	43	290	333	High	USA	1000
Hyundai de Mex. 2	50	106	*	150	306	High.	S. Korea	1100
ERTL	74	143	*	*	217	Moderate	USA	600
Am. Opt. Lens	58	139	*	*	197	High	USA	850
Baterias CSB de Mexico	*	*	*	185	185	Moderate	Taiwan	n.d.
Value Printed Circuits	*	107	51	0	158	Moderate.	USA	170
Power Sonic				149	149	Moderate	USA	400
Coastcast	*	99	36	*	135	Moderate.	USA	3450
Yaginuma Press	70	*	*	*	70	Moderate	Japan	100
Servicios Ambientales	70	*	*	*	70	n.d	Mexico	n.d.
Cintas Vac	47	*	*	*	47	Minimal	USA	155
SSD Plasticos Mex.	44	*	*	*	44	Moderate	Japan	220
Transportes PG	*	*	42		42	High	n.d.	n.d.
Maderas Exoticas	43	*	*	*	42	High	USA	800
Mabamex	*	*	35	*	35	Minimal.	USA	1595
Total	1054	4041	1593	4789	11481			

* Asterisks indicate that the plant was not in the top ten for that year, although it may have generated hazardous waste that did not make it into the top 10..

Sources: U.S. EPA. (2001) *Haztraks*. San Francisco, CA.

Size = No. of Workers from Solunet. (various years). *The Complete Twin Plant Guide*. I and Canacintra: (1997) *Directorio industrial Tijuana.*

Discussion

What are the implications of these findings for the well being of the densely populated industrial cities at the north of the Baja California peninsula? The fact that the greatest generators of some of the riskiest hazardous waste have recently set up shop in communities, in many cases right next door or across the street from residential and commercial districts, employing large numbers of local workers, need not be a cause for alarm if hazardous waste is properly handled. However, the risks can become a reality due to bad management, accidents, or lack of government enforcement of environmental law. An example of each of these will be briefly discussed to show that safe management of risks cannot be assumed. A consideration of the examples indicates why proximity to local populations is important.

• Bad Management. The author conducted in-depth interviews at *Factor X/Casa de la Mujer*, a Tijuana NGO that develops courses for women maquiladora workers on health and safety. The sessions from the first course were tape recorded and transcribed, and these transcriptions made available to the author. They revealed that one of the top ten generating plants in 1996 and 1997 practiced environmental racism in the workplace, which resulted in darker-skinned men suffering negative health consequences. Johnston and Button (1994) define environmental racism as the selective application of environmental protection measures. The name of this company is confidential, but it is among those found in this study to be the Top 10 generators of hazardous waste. The following classroom dialogue allows us to hear workers' voices and their perceptions:

Course participant: "Where I work, there's an area that uses a lot of chemical resin. People fall very easily because of the slippery floor. With this same chemical, the hands of the men swell up terribly. It's all men who work in this part, and the skin gets red."

Course participant: "For that area they hire all dark-skinned people because they say that dark skin is more resistant."

Course participant: "They moved me from that area because the resin did me a lot of damage. Curiously I felt nothing at first. After I began to feel it."

Course participant: "That resin that I am telling you about gives them influenza and it doesn't go away. I know people who have been there thee, five years and never have gotten rid of it. It's because of this same chemical resin."

Course participant: "White skin is weaker."

Course Instructor: "The effect is the same for dark-skinned people. It's only that you don't see it. And when it's not visible, they believe there's no damage." [13]

• Accidents. The 1997 fire at Pacific Treatment and its contaminating effects have been discussed above. It is interesting to note that many of the plants reporting generating hazardous waste to SEMARNAP in 1998 said that it was sent to Pacific Treatment for burning or confinement. Fires such as this are not unusual. For example, Mulay Plastics, a Chicago-based company that manufactures casings for Sony, Sanyo, and Mitsubishi in Pacifico Industrial Park had a fire in 2000 which produced dense toxic smoke. Fortunately, the wind blew the smoke away from densely populated residential neighborhoods.[14] However, dense concentrations of plants within Tijuana, and their proximity to residential areas, mean that this cannot be guaranteed.

• Lack of enforcement of Mexican environmental Law. *Metales y Derivados*, a car battery recycler located on the southern edge of the *Mesa de Otay* in *Ciudad Industrial* is an example of an irresponsible hazardous waste generator who was found to have violated Mexican environmental law and closed. The residential district *Ejido Chilpancingo* is the home of

[13] Interview at *Factor X/Casa de la Mujer*, July 26, 1999, Tijuana, B. C. The staff members Reyna Montero and Beatriz Alfaro were interviewed. Quotations are from the fifth session of the course "Training on Health and Safety at Work," which focused on hazards in the workplace. The course was held from March 20-24, 1999 in Tijuana. Quotations were translated from Spanish by the author.

[14] Fire engulfs U.S. maquiladora warehouse in Tijuana. 2000. *San Diego Union-Tribune*. May 29: B8.

approximately 1,000 families located just below the mesa at the back of the plant. Many of the residents complain that the toxic material blows down with the wind or is washed down by the rain, and causes eye irritation, skin rashes, headaches, as well as hyperactivity and lowered intelligence in children. Children have also been born with anencephaly but there is not direct proof that these health problems have been caused by the contamination (Lindquist, 1993; Dibble, 1998). The owner is a Chilean national who resides in San Diego with impunity. Eight years after the factory was closed in 1994, over 7,000 metric tons of lead slag remained on the abandoned factory site. Despite exhortations to clean it up, it remains open to the air and accessible to the public. This hazardous situation continues even though the Commission for Environmental Cooperation published a factual record which confirmed the dangers (CEC: 2002). This report is an excellent source of information, but the environmental side deal of NAFTA was constructed so that only the facts could be stated. The report makes no mention of action to be taken. As Connie Garcia, a spokesperson for the Environmental Health Coalition, one of the two NGOs making the complaint against *Metales y Derivados* to the CEC said, "All that work in submitting our case, and all they gave us was a book."[15]

It has been acknowledged that the potential for such risks are realized more on Mexico's northern border than in other areas of Mexico. The *Instituto Nacional de Ecología* has identified the northern border region as a zone that is particularly negatively affected by hazardous waste due to inadequate handling of the wastes in the process of the fabrication and assembly of electronic equipment and electronics.[16] This is directly related to population growth and maquiladora activity in this region.

Asian origin maquiladoras may be more likely than some other firms to guard against the risks of the large amounts of hazardous waste they generate because they have more complete administrative and

[15] Personal communication with Connie Garcia, at the San Diego EPA Open House, April 10, 2002.

[16] Instituto Nacional de Ecología, SEMARNAP, con datos para la Minimización del Manejo Integral de Risiduos Industriales Peligrosos en México, 1996-2000/www.ine.gob.mx)

organizational structures, as argued above. Also, they can be considered less likely to have transferred production across international boundaries to North America in order to avoid paying the environmental costs of their production processes. If cutting environmental costs was their main goal, they probably would have moved to China. As the recycling manager cited above indicated, in 1992 and 1993, most of the waste handled by his company came from furniture production. It is well known that many U.S. owned furniture companies which used to be located in the Los Angeles area moved south of the border after strict environmental laws were passed in southern California (Berry, 1994: 67). Many intentionally transferred their production processes to Mexico to avoid paying the higher costs which would have been involved in complying with the new U.S. laws.

The main reasons Asian origin firms have moved to Mexico have more to do with geopolitical and conjunctural factors, than avoiding the payment of environmental costs. They want to be close to both the US and Latin American markets to ensure accessibility, prompt delivery of their products, and to be more competitive with US producers in the same sector. Another important reason for the increase of Asian origin investment in Baja California in the late nineties was the desire to transfer more production and suppliers before NAFTA was fully implemented so that they would be legally North American and avoid paying taxes for imports coming from outside of North America. This boom in Asian origin investment may not continue after NAFTA is fully implemented. The treaty specifies that after 2001, non-North American inputs would no longer enjoy tax free status, and the Mexican government has not been clear about what alternative taxes will be imposed, discouraging many non-North American investors.

Samsung Display Devices, the largest generator of hazardous waste found in this study , is a good example. On February 9, 1999, the author led a class of Mexican social science doctoral students from *El Colegio de la Frontera Norte* on a plant visit, which included a video presentation, oral presentations by the senior production manager and the general supervisor of training, two question and answer periods, and an extensive guided tour of large parts of the plant. The senior production manager, a Mexican

engineer, said that geography was the reason Samsung had decided on this location. Its primary reason was to be close to the U.S., and especially the California markets, because they are the biggest in the world. The plant opened in the mid-nineties to avoid taxes later under a fully implemented NAFTA, which prefers North American suppliers. Samsung came to Mexico, because their most expensive costs, which are for water and electricity, are cheaper in Mexico than in the United States. They chose Tijuana because they supply other companies located in the same area, such as Sony, JVC, and Panasonic.

However, environmental issues make Samsung's production problematic and less efficient than desired. He said that water costs twenty times more in Tijuana than in South Korea, and they can't use 25 percent of what they acquire because of its bad quality. This makes it impossible for Samsung's Tijuana operations to compete very successfully with other plants owned by the same company around the world, despite the low cost of Mexican labor.[17] This dilemma is a good example of Sklair's argument, sited in the introduction of the paper, that export led development thrives in environmentally unsustainable conditions. Every summer, water is cut temporarily in various residential areas of Tijuana due to lack of supply, sometimes for as much as a week, while it continues to flow to tourist developments and industrial parks.

Finally, the propensity to guard against the risks of hazardous waste may be due more to the strategy of individual firms, rather than the origin of their capital. Some firms go beyond the basic legal standards of environmental responsibility. A positive example is Sony's celebration of its founding day on May 10, 2001 by having 200 of its employees voluntarily clean up local streets, parks, and beaches in Tijuana. Even more importantly, Japanese credit given to the Baja California state government in 1999 allowed it to borrow money from NAFTA's NADBANK in order to invest in infrastructure for potable water and drainage in Rosarito.[18] There is reason to believe that those plants ending up as the top ten generaters of

[17] Miguel Hernandez, Sr. Manager Production 1, Samsung, North America Tijuana Park.
[18] Araceli Domínguez. 1999. Agua y drenaje para Rosarito con crédito japonés: Grijalba Palomino. *Ecos de Rosarito*. 11 de junio: 1, 31.

hazardous waste do so because they have been more environmentally responsible. Cintas Vac, for example, which is shown in Table 5 to have been among the top ten generators of hazardous waste in Tijuana in 1996, installed a two million dollar solvent recovery system in 1995 which allowed it to recover more than 99 percent of the solvents used in its tape manufacturing processes and re-use them. The system was said to set a standard for Mexican environmental awareness by meeting and exceeding the toughest world standards, which are set in the neighboring U.S. state of California (Daley, 1996).

On the other hand, PROFEPA's 2001 inspection of *Hyundai de Mexico* found it in violation of environmental law in its "management of toxic materials and industrial waste, its use of water, excessive gas and particulate emissions, and its storage and use of hazardous substances." (Lindquist: 2002) PROFEPA closed the plant for five days until it addressed the most serious offences, and ordered the company to post a bond of two million dollars, the largest every imposed in Tijuana. Hyundai cooperated and posted the bond. PROFEPA said it would decide on whether or not there would be any fines after Hyundai had completed its process of complying with environmental law. The bond amount of two million dollars is greater than any fines that could be levied however, and the unusual step of imposing the bond was taken to insure that Hyundai would be more likely to comply. This is just the latest time Hyundai has been inspected and found not complying with environmental law, since there were several occasions in which this happened during the nineties, as indicated in the official report regarding this by the U.S. National Administrative Office of International Labour Affairs, the branch of the U.S. Labor Department empowered to oversee compliance with NAFTA's labor side agreement.[19]

Several policies might be developed to help guard against the risks of hazardous waste. Mexico's environmental laws need to be improved and implemented to ensure that industrial hazardous waste is either properly

[19] U.S. National Administrative Office Bureau of International Labor Affairs U.S. Department of Labor "Public Report of Review of NAO Submission No. 9702 Part II: Safety and Health Addendum" [online] August 11 1998 [Cited February 19, 2002]. Available from: http://www.dol.gov/dol/ilab/public/media/reports/nao/9702partII.htm#i

treated in Mexico or returned to its country of origin. As the fifth report of the EPA related Good Neighbor Environmental Board (2001: 41-42) indicated "Current Mexican law allows generators of hazardous waste to be stored indefinitely on site, meaning that facilities in Mexico may be *de facto* hazardous waste storage facilities, with increased risk to public health and safety. ... This potentially enables long-term storage at generating facilities such as maquiladoras. In theory, complete inventories of hazardous waste could be abandoned at facilities." Mexican laws should be reformed to allow storage of hazardous waste on site for shorter times.

Data must to be more available to researchers and the public at large in order to avoid exposure to hazardous waste, which is often located very close to densely populated residential areas, particularly those with young children. The misperception expressed by workers in the dialogue quoted above, that hazardous materials harm white skinned people more than dark skinned people, indicates that safe handling practices need to be taught to and adopted by people living near plants and those working in them. PROFEPA should increase its inspection rate, to prevent plants from illegally dumping waste into the sewerage system or burying it near their plants. In order to do this, they will need more resources, such as more personnel in the *Ministerios Públicos*. In October, 1999, the *subdelegado* of PROFEPA in Tijuana said that the case of *Metales y Derivados* was only one example of the many companies found to be illegally contaminating their sites and communities which have not proceeded effectively.[20] Due to lack of personnel, there is often inadequate follow up by inspectors to insure that companies found to be in violation carry out the necessary reparations.

City authorities need to enforce zoning regulations which prohibit new plants from locating in densely populated areas. The state of Baja California N. reformed its environmental law in 2001 to forbid the location of contaminating industries close to residential neighborhoods, but more needs to be done in terms of enforcement. The Ensenada city authorities have taken a lead, in asking plants which are improperly located to relocate

[20] Isabel Tejada. 1999. No hay Ministerios Públicos en delitos ambientales. *Frontera* (Tijuana). 14 de octubre.

themselves. Plants moving out of industrial parks and into residential areas to reduce their high turnover rates might be able to solve their labor problems more safely with better transportation for workers who can then live farther away. Government authorities are beginning to educate Mexicans about their right to protest the installation of a contaminated business next to their homes, but much more is needed in the way of creating buffer zones around already existing high risk industries.

While everyone hopes that a major earthquake never occurs, it would be prudent to develop plans to deal with potential disasters. This has been taken into account in the construction of some recently built infrastructure, such as the South Bay Ocean Outfall, the 3.6 mile tunnel which takes partially treated sewage from the treatment plant on the border and releases it into the Pacific three miles offshore. It crosses 14 fault zones and was hardened to withstand an earthquake of 7.5 on the Richter scale (Booth: 1998). More needs to be known about where hazardous wastes are generated in the city, how long they are stored there, and who is likely to be exposed to them in case of an emergency such as an earth quake. Cervera (1998), who defined areas of risk in Nogales, Sonora, which included many residential neighborhoods and schools adjacent maquiladoras, suggested that there be evacuation plans in every plant and household.

The Mexican government not only lacks sufficient resources to enforce its environmental law, but even when companies are fined, it is often cheaper for them to pay the fines than for them to not have violated them in the first place. This is due to the fact that large multinational corporations, regardless of their origin, often have more resources than less developing nations such as Mexico. East Asian origin maquiladoras located at the head of the Baja California peninsula, because they are the largest firms and generate the greatest amounts and highest risk hazardous waste, may be in the best position to take the moral leadership in being good examples of those who report the hazardous waste generated and handle it properly.

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Abstract

Environmental Implications of New Mexican Industrial Investment: The Rise of Asian Origin Maquiladoras As Generators of Hazardous Waste

Kathryn Kopinak

This paper explores some implications of the largest recent investments in Mexican maquiladoras using data collected from SEMARNAP in Mexico and the EPA in the United States. The findings indicate that the increase in Asian origin investment in maquiladoras at the western end of the U.S.-Mexico border has reterritorialized the generation of hazardous waste. Central and eastern cities such as Cd. Juárez and Matamoros, which used to have the plants generating the most, now fall far behind Tijuana and Mexicali, whose new Asian investors have taken the lead. Moreover, South Korean, Japanese, and Taiwanese owned maquiladoras have caused their cities to more than triple the amount of hazardous waste generated anywhere else, and theirs are the riskiest materials. These results are interpreted in terms of globalization, which has made it legally possible for the risks of industrial production to occur in areas other than where products are consumed or profits realized. Policies to avoid and reduce risks are suggested.

Key words : maquiladora, hazardous waste, environmental risk