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ENVIRONMENTAL MANAGEMENT SYSTEMS (EMSs) AND REGULATORY INNOVATION

KEITH PEZZOLI*

INTRODUCTION

Traditional regulatory approaches are failing to resolve some of most serious environmental problems prevalent today (e.g., global warming, proliferation of hazardous wastes, water pollution from diffuse sources). Recognizing this, many environmental agencies are pursuing a variety of new strategies. One of these seems especially promising and is the subject of this paper: a set of new organizational and managerial plans known generically as Environmental Management Systems (EMSs). An organization with an EMS in place is distinguished from a traditional organization most of all by how it incorporates pollution prevention and resource conservation into its ongoing business decisions and activities. Traditional organizations typically do not have such an integrated approach to environmental considerations; rather they have a reactive approach designed to comply with narrowly defined, and often fragmented, government regulations. What follows is a discussion of what EMSs are, and why they have gained popularity in both the public and private sector.

The analysis suggests that EMS initiatives are emerging in response to certain limits (involving domain, functional, structural and political factors) posed by the legacy of "first generation" environmental policy. With these limits in view, the paper describes the efforts of the California-led, Multi-State Working Group (MSWG). The MSWG is in the early stages of developing a national research strategy for regulatory innovation. As a part of this process, an EMS database is being developed to provide publicly accessible information from over 100 pilot projects across country. The MSWG's award winning program is the most significant research-driven environmental policy initiative in the U.S. today. For comparative purposes, this paper also refers to Mexico's *Industria Limpia* (Clean Industry) Program and the Guadalajara Environmental Management Pilot (GEMP) Project. The pa-

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per reflects on these national efforts to suggest an agenda for research and practice in the San Diego-Tijuana global city region.

I. EMSS AND ISO 14001

The California Environmental Protection Agency (Cal/EPA) defines an EMS as "a process by which an organization's management identifies regulated and unregulated environmental aspects and impacts of its operations, assesses current performance, and develops targets and plans to achieve significant environmental improvements."¹ California Governor Gray Davis recently established the Cal/EPA EMS Innovation Initiative, the purpose of which is to find more effective and innovative ways to achieve superior environmental protection. The Governor's initiative targets the inefficiencies of environmental policy built on principles of "command-and-control."

The potential benefits of EMSSs go beyond individual firms or organizations. Benefits can be also achieved at the level of supply-chains, whole industrial clusters, sectors, regions, and even transnational networks. Other positive outcomes may include improved industry-community relations and industry-government relations. To date, there is little beyond scattered anecdotal evidence that EMSSs are an effective tool for more efficiently achieving environmental and economic goals. However, environmental protection agencies around the world, including those in the U.S. and Mexico, have launched research-driven policy initiatives to examine the potential benefits and limitations of EMSSs.²

The rising interest in EMSSs and voluntary environmental management standards has been fueled by the International Organization for Standardization (ISO).³ The ISO is a private sector, worldwide federation of national standards setting bodies from 130 countries. Founded in 1947, the ISO now has considerable influence in international trade. It promotes the global harmonization and development of standards applicable to manufacturing, products and communications. ISO's mission is to facilitate the international exchange of goods and services, and to develop cooperation in the spheres of

1. CALIFORNIA EPA, ENVIRONMENTAL MANAGEMENT SYSTEM INNOVATION INITIATIVE, FIRST QUARTERLY REPORT TO THE LEGISLATURE 2, submitted Dec. 31, 1999 [hereinafter FIRST QUARTERLY REPORT].

2. See proceedings of the Cal/EPA conference, Innovations in Environmental Management: Successful Models for a Sustainable California, Co-Hosted by the Resource Renewal Institute and the California Environmental Protection Agency, Claremont Hotel, Berkeley, California (Oct. 26-27, 1999) (copies can be obtained from Thomas P. Lanphar at the Cal/EPA Department of Toxic Substances Control, 700 Heinz Ave., Suite 200, Berkeley, CA 94710-2721).

3. Regarding the emergence of ISO 14001, see generally Donald A. Carr & William L. Thomas, *Devising a Compliance Strategy Under the ISO 14000 International Environmental Management Standards*, 15 PACE ENVTL. L. REV. 85 (1997) (sources cited at p. 152, n.160 include excellent articles by Christopher Bell, and at n.133, by Naomi Roht-Arriaza); see also Donald A. Carr & William L. Thomas, *ISO 14001 Sets a Global Environmental Standard*, NAT'L L.J., July 8, 1996, at C2.

intellectual, scientific, technological and economic activity.⁴ In 1996, ISO released its “ISO 14000” series of voluntary environmental standards and guideline reference documents covering such things as EMSs, eco-labeling, environmental auditing, life cycle assessment, environmental performance evaluation, and environmental aspects in product standards. The principal document of this series is ISO 14001, an EMS standard. ISO defines an EMS as “the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the [organization’s] environmental policy.”⁵ The California Environmental Protection Agency (EPA) notes that “[a]n EMS is designed to integrate environmental management into the organization’s overall management system by identifying the policies, environmental targets, measurements, authority structures and resources necessary to produce both compliance with regulations as well as beyond compliance environmental performance.”⁶

The ISO 14001 EMS standard is beginning to influence the global economy’s competitive landscape and the concomitant environmental stance of firms in both developed and developing countries.⁷ A range of factors motivates firms to adopt a formal EMS. One recent study of six chemical plants registered to the ISO 14001 standard found that the primary aim was to improve compliance and environmental performance.⁸ Additional factors are coming into play as the scope and practice of environmental management has gradually broadened. Leading-edge companies are grappling with the “triple bottom line” of sustainability that includes eco-efficiency, ethics, and corporate social responsibility.⁹ In this context, firms adopt EMSs not only to save money and avoid expensive litigation, but also to gain public recognition for environmental leadership, commitment, and responsibility.¹⁰ The benefits derived from such recognition may include, for instance, higher

4. See *International Organization for Standardization* (visited Feb. 23, 2000) <<http://www.iso.ch/>>. The term ISO is a Greek word meaning equal, it is not an acronym for the organization.

5. ISO 1996 14001: 3.5.

6. FIRST QUARTERLY REPORT, *supra* note 1, at 2.

7. Regarding firm experience with the standards, see Jason Switzer et al., *ISO 14001 and Environmental Goal Setting: Promises Kept*, ENVTL. QUALITY MGMT., Winter 1999, at 1.

8. See JENNIFER NASH, JOHN R. EHRENFELD, J. MACDONAGH-DUMLER, & P. THORENS, ISO 14001 AND STAR TRACK: ASSESSING THEIR ROLE IN ENVIRONMENTAL PERFORMANCE IMPROVEMENT (1999), *cited in* Jennifer Nash & John R. Ehrenfeld, *Environmental Management Systems and Their Role in Public Policy*, in ENVIRONMENTAL MANAGEMENT SYSTEMS, NATIONAL RESEARCH SUMMIT (Multi-State Working Group on Environmental Management Systems, ed., 1999)[hereinafter *Environmental Management Systems*].

9. See Kathleen M. Victory, *Focus Report, Past as Prologue: A Decade’s Worth of Changes in Environmental Management*, BUSINESS AND THE ENVIRONMENT, Jan. 2000, at 2.

10. Regarding trends in environmental management strategy, see William L. Thomas et al., *Using Auditing, Pollution Prevention, and Management Systems to Craft Superior Environmental Enforcement Solutions*, 30 ENVTL. L. REP. (Envtl. L. Inst.) (forthcoming 2000) manuscript at n.55 (citing recent sources).

stock values and lower insurance premiums. Other factors motivating firms to adopt EMSs come from trade associations, customers and government agencies (e.g., peer pressure, customer demands for environmental-friendly products/processes, regulatory incentives).¹¹

The Dow Jones recently joined forces with SAM Sustainability Group Indexes and launched a special sustainability Index (DJSIGI) to track the environmental performance of industries.¹² About this development, the President of a prominent environmental management consulting firm said, “[t]he main idea was that the sustainability index and the [Dow Jones] household name in the financial sector lends new credibility to environmental management systems and performance metrics. The connection here is that EMSs and metrics that support those systems are the essential tools to moving toward sustainability.”¹³

Recently, Ford and General Motors established “green” procurement guidelines and announced that they expect their suppliers to conform to the ISO 14001 EMS standard. This will impact thousands of companies that sell billions of dollars worth of goods and services to Ford and General Motors. In providing the rationale for this move, Ford spokesman Ron Iori said, “[w]e realize we have quite a long supply chain and value chain that goes into making vehicles, and this is one way we can make that chain more environmentally friendly.”¹⁴ Along similar lines, the Clinton Administration is expected to mandate that nearly all federal agencies adopt the ISO 14001 EMS standard.¹⁵ Given the enormous volume of goods and services that flow through federal systems of production, consumption, and distribution, this mandate is bound to have a very significant impact, especially now that the EPA has an official policy to promote the use of EMSs. The EPA requires companies with compliance problems to implement an EMS as a condition for settling enforcement cases.¹⁶

From the time of its release in 1996 until April 1998, 2800 facilities worldwide were certified to be in compliance with ISO 14001. By June 1, 1999, a total of 10,439 organizations were certified to the standard; the U.S. ranks seventh worldwide with 460 certifications. Japan has the most certifi-

11. See generally *Environmental Management Systems*, *supra* note 8.

12. Regarding EMS and financial services community, see William L. Thomas, *Environmental Performance of Client Firms Assumes Greater Importance for Financial Services Industry*, INT’L ENVTL. SYS. UPDATE, Dec. 1998, at 16.

13. *Dow Jones Launches Index to Track Environmental Performance*, 6 INTERNATIONAL ENVIRONMENTAL SYSTEMS UPDATE, at 11; see also *Dow Jones Sustainability Group Index* (visited May 29, 2000) <<http://indexes.dowjones.com/djsigi>>.

14. Reuters News Service, *Ford and General Motors Establish Green Procurement Guidelines*, USA TODAY, Sept. 22, 1999.

15. See *Sweeping Reform, President to Mandate EMSs for All Federal Agencies: Executive Order Outlines Environmental Management as ‘Fundamental Component’ of U.S. Government*, INT’L ENVTL. SYS. UPDATE, Nov. 1999, at 2.

16. See REPORT OF THE EPA INNOVATIONS TASK FORCE, AIMING FOR EXCELLENCE: ACTIONS TO ENCOURAGE STEWARDSHIP AND ACCELERATE ENVIRONMENTAL PROGRESS (July 1999).

cations with 2124. Germany ranks second with 1400 and the UK third with 947. Mexico has forty-eight registered organizations putting it in thirtieth.¹⁷ Roughly a half dozen firms in San Diego and a half dozen in Tijuana are now certified. Cases in San Diego, for instance, include Kyocera, a semiconductor packaging operation; SGS-Thompson Microelectronics, a semiconductor manufacturer; and Qualcomm, a wireless communications equipment manufacturer. Among the cases in Tijuana there are two maquiladoras, namely Square D, a manufacturer of electrical circuit breakers; and Sony, a manufacturer of TV sets. The first firm in the U.S. to become ISO 14001 certified was SGS Thompson, a San Diego-based Microelectronics Corporation. A number of industries in Baja California, including Square D and Sony, have also been certified. In the Baja California-California region, the Western Maquiladora Trade Association has actively promoted ISO 14001 certification among its members. At the binational level, the U.S.-Mexico Border XXI program's *Principles of Environmental Stewardship for the 21st Century* emphasize the importance of EMSs as an integral approach to sustainable development.¹⁸

The ISO 14001 EMS standard was designed to be applicable to a wide range of types and sizes of organizations across the globe. Unfortunately, the manner in which the standard took shape (i.e., through international negotiation and compromise) has left it with what some consider to be two significant weaknesses. First, it does not require compliance with environmental legislation, only a commitment to compliance, a mechanism for identifying regulatory requirements, and a plan for achieving them. Second, only the organization's environmental policy statement has to be publicly communicated, not the environmental aspects of the operation nor the organization's environmental program.

In light of these and other perceived weaknesses, a working group of experts representing national member bodies to the ISO Technical Committee on Environmental Management (TC 207) voted, during November 1999, to revise the ISO 14001 standard. The top debates concerning possible revisions include: (1) Making the standard more compatible with ISO's Quality Management System (9001); (2) Clarifying the standards more ambiguous phrases such as "environmental aspects identification" and a "commitment to compliance with regulations;" (3) Recasting the definition of "pollution prevention;" and (4) Defining more clearly the extent to which a certified organization is obligated to maintain external communication with the public.¹⁹

17. There is an ISO Information Center at <<http://www.iso14000.com>> that routinely updates a graphical representation of numbers of registrations to ISO14001 and EMAS certifications shown by country. See *The ISO Information Center: Registered Companies Database* (visited Feb. 23, 2000) <<http://www.iso14000.com/Registered/ViewDatabase.asp>>.

18. U.S. MEXICO BORDER XXI DOCUMENTS, U.S./MEXICO BUSINESS AND TRADE COMMUNITY: THE SEVEN PRINCIPLES OF ENVIRONMENTAL STEWARDSHIP FOR THE 21ST CENTURY, July 1999, available at *U.S. Mexico Border XXI Home Page* (visited Feb. 25, 2000) <<http://www.epa.gov/usmexicoborder/ef-doc.htm>>.

19. Cutter Information Corp., *ISO Revision Process Gets Green Light*, BUSINESS AND THE

The TC 207 is also charged with the task of producing an official Spanish-language translation of ISO 14001 by June 2000.²⁰

The concerns to be addressed during the ISO 14001 EMS standard revision (to be completed by 2003) are substantial. Clearly, ISO 14001 is not perfect. At the same time, however, interest in the ISO's EMS standard is indicative of an important shift in emphasis taking place within regulatory agencies and among the regulated. Greater emphasis is being placed on proactive means to prevent pollution as opposed to controlling it at the end-of-pipe.²¹ An EMS-based approach operates from the premise that changes in corporate organization, culture, and procedures can yield environmental improvement in ways that a regulatory driven, compliance-based approach cannot. If effectively implemented, "a system of this kind enables an organization to establish, and assess the effectiveness of, procedures to set an environmental policy and objectives, achieve conformance with them, and demonstrate such conformance to others."²² The overall aim is "to support environmental protection and prevention of pollution in balance with socio-economic needs."²³ While this all sounds great in principle, the various stakeholders involved (e.g., industry, government, community) each raise concerns. Some businesses are concerned that EMSs may be too expensive for the value they add. Governments—while considering the potential benefits of relying upon EMSs to give industry "regulatory flexibility"—do not want to risk abdicating any control that may prove harmful in the end. Likewise, non-governmental community groups (NGOs) have a cautious attitude.

II. HISTORICAL CONTEXT

Although statutes and regulations to control pollution and manage wastes have been in place in big cities around the world for hundreds of years, not until the late-1960s and early-1970s did environmental concerns enter the legal-institutional mainstream of the world's most developed countries. The National Environmental Policy Act (NEPA), signed into law on January 1, 1970, is generally considered a milestone in U.S. legislation. Between 1970 and 1974 many additional legislative initiatives, regulatory activities, and court actions dealing with environmental issues took center stage. The foundation for U.S. environmental protection efforts now consists of several pieces of major environmental legislation, such as the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act. The U.S. Environmental Protection Agency (EPA) is the administrative agency responsible for the implementation of these laws. State and local regulatory

ENVIRONMENT ISO 14000 UPDATE: GLOBAL NEWS AND ANALYSIS OF EMS DEVELOPMENTS FROM THE CUTTER INFORMATION CORP., Vol. VI, No. I, at 3.

20. See THE ENVIRONMENTAL MANAGEMENT REPORT, Vol. 4, No. 10 (Oct. 1999).

21. See Carr & Thomas, *supra* note 3, at 85, sources cited at 86-87.

22. ISO 14001, p. v (1st ed. 1996).

23. *Id.*

agencies are also granted authority for enforcing the laws. As a result, the U.S. features a complex network of state and federal programs based on an extensive system of environmental standards, permitting, and enforcement procedures.²⁴

In the case of Mexico, efforts to create a legal system for environmental protection didn't get serious until the late-1980s. The legal regime that targets the environment in Mexico is an ensemble of laws, regulations and standards that are implemented by a combination of federal, state and local government authorities. Environmental planning in Mexico takes place within a civil law system that relies largely on administrative institutions and measures for interpreting and enforcing its laws.²⁵ In contrast, the U.S. legal system relies on juridical institutions and litigation as well as administrative regulation and review. Dispute settlement and law enforcement within Mexico's civil law tradition depends largely on administrative mechanisms and negotiation between parties. Consequently, there is greater relative power vested in the executive governmental bodies to take unilateral actions, and there is greater use of administrative rather than judicial authority to achieve enforcement.

The antecedents of environmental law and planning in Mexico can be traced to Article 27 of Mexico's founding Constitution which incorporated the concept of natural resource conservation (Carmona Lara 1991: 26). But the current foundation for Mexico's environmental protection program wasn't laid down until 1988 when Mexico passed its first General Law of Ecological Balance and Environmental Protection (*Ley General del Equilibrio Ecológico y la Protección al Ambiente*, also know as the *Ley General de Ecología* or General Ecology Law)²⁶ Mexico's General Ecology Law was written using U.S. environmental law as a model. It is comprehensive in scope and covers all media including air, water, and solid waste handling and disposal. It also considers natural resource conservation, ecological zoning, and all pollution problems.²⁷

24. See generally ROBERT GOTTLIEB, *FORCING THE SPRING: THE TRANSFORMATION OF THE AMERICAN ENVIRONMENTAL MOVEMENT* (1993).

25. For a thorough technical review of Mexican environmental law, see CARMONA LARA, MARÍA DEL CARMEN, *DERECHO ECOLÓGICO* (1991); Universidad Nacional Autónoma de México (Instituto de Investigaciones Jurídicas). For a review of current environmental law and policy see Antonio Azuela, *Property Rights, Environmental Regulations, and the Legal Culture of Post Revolutionary Mexico*, a paper presented at the symposium "Democracy and the Rule of Law in a Changing Global Order," organized by the Library of Congress and New York University (March 2000). The text of many of Mexico's most important current laws can be viewed on-line. See *Semarnap Profepa* (visited May 29, 2000) <<http://www.profepa.gob.mx/leyes.htm>>. The text of Official statements concerning developments in Mexican environmental law and policy can also be viewed online. See also *Medio Ambiente, Percursos Naturales y Pesca* (visited May 29, 2000) <<http://www.semarnap.gob.mx/gestion/avances/presentacion/index.htm>>.

26. The full text of this law can be read on-line. See *LGEEPA* (visited Feb. 25, 2000) <<http://www.ine.gob.mx/uaj/lgeepa/index.html>>.

27. See *Ley General del Equilibrio Ecológico y la Protección al Ambiente (LGEEPA)*,

The legally mandated approach to environmental protection in both the U.S. and Mexico is often characterized as a “command-and-control” system. It gets this label because the government “commands” the target levels for pollution reduction while it also “controls” the means for reaching said targets. In directive-based regulation of this sort, a public authority sets standards while monitoring and enforcing compliance. E. Donald Elliot does a good job describing the main elements of this approach in the U.S.:

(1) pollutant-by-pollutant, or industry-by-industry regulation carried out by government under federal statutes after lengthy administrative proceedings and court challenges; (2) minimum standards set by administrative agencies at the federal level limiting the amount of pollution that may be put into the air, water, or land; (3) requirements that the state’s translate federal goals into facility-specific legal requirements for individual factories or other sources of pollution; and (4) establishment of legal rights for environmentalists and other citizen groups to sue to enforce pollution laws, including bringing actions to force the government to act by deadlines specified in the law.²⁸

The traditional system described above has been characterized as “first generation” environmental policy. Some would like to see it dismantled altogether in favor of a less regulatory driven and more market-based approach. Others think that government oversight has not been strong enough. At the extreme, these opposing views characterize regulatory issues in “either/or” terms: There will be either a healthy environment and a devastated economy, or a healthy economy and a devastated environment. Most of those concerned with these issues fall somewhere between these extremes, and most would agree that first generation environmental policy has delivered some significant results. In the U.S., as in most other OECD countries, one no longer sees the kind of major point sources of pollution that used to be common place (e.g., belching smokestacks, factory pipes discharging heavy flows of noxious effluent directly into rivers and waterways). Most would also agree, however, that in developing countries, such as Mexico, the enforcement of environmental laws has been a serious problem.

During December 1994, some major changes were made in Mexico in an attempt to streamline environmental policy and enforcement. The main government offices that deal with environmental concerns in Mexico were integrated into the new Secretariat of Environment, Natural Resources and Fisheries (*Secretaría del Medio Ambiente, Recursos Naturales y Pesca*; SEMARNAP). This new ministry—which coordinates the development and implementation of environmental policy—houses the National Water Commission, the National Institute of Ecology, and the Federal Environmental

published in DIARIO OFICIAL DE LA FEDERACIÓN (Jan. 28, 1998); see also *Semarnap Profepa* (visited May 29, 2000) <<http://www.profepa.gob.mx/leyes.htm>>.

28. E. Donald Elliot, *Toward Ecological Law and Policy*, in THINKING ECOLOGICALLY: THE NEXT GENERATION OF ENVIRONMENTAL POLICY 171 (Marian R. Chertow & Daniel C. Esty eds., 1997).

Protection Enforcement Agency (*Procuraduría Federal de Protección al Ambiente*, PROFEPA). These bodies develop and administer regulations pertaining to air, water, and noise pollution, and evaluate environmental impact statements. The General Ecology Law (1988) and the National Water Law (1992) are the most significant legislation authorizing the federal government to develop and enforce environmental regulations and technical standards. Enforcement of these regulations and standards is carried out by PROFEPA. The NAFTA-spawned Commission for Environmental Cooperation (CEC) has found that while SEMARNAP and its associated government agencies (GA) have pollution-prevention programs, or promote them to some extent, the general perception in industry and among many environmental consultants seems to be that the GAs have not yet taken an active enough role in promoting them. The priority of most GAs is biased toward achieving compliance through pollution control strategies.²⁹

For a number of reasons, including how difficult it has been to promote pollution prevention in both Mexico and the U.S., the term “command-and-control” has taken on a pejorative connotation. A growing number of policymakers, researchers, environmental activists, industrial managers and government officials agree that the traditional regulatory approach is experiencing diminishing returns. Understanding these limits helps explain why there has been a rising level of interest in EMSs and regulatory innovation.

III. THE LIMITS OF FIRST GENERATION ENVIRONMENTAL POLICY

Both the U.S. EPA and Mexico’s Secretariat of the Environment (SEMARNAP) are exploring more flexible regulatory approaches based on government-industry collaboration (e.g., co-regulation). Much of this effort has focused on voluntary Environmental Management Systems (EMSs) and voluntary standards. A number of organizations (comprised of company representatives, and to a lesser extent, environmental NGOs) have developed codes for corporate environmental management practice. A major development along these lines took place during April, 1991, at the *Second World Industry Conference on Environmental Management* held in Rotterdam, the Netherlands. At this conference, the International Chamber of Commerce (ICC) adopted the *Business Charter for Sustainable Development*. Targeted to a similar audience, the *Coalition for Environmentally Responsible Economies (CERES)* has developed a reporting framework for businesses.

The proliferation of business charters, voluntary environmental standards, and corporate codes of conduct have influenced how firms consume resources, prevent pollution, report their environmental impacts, and interact with the public.³⁰ In some academic circles, the high hopes pinned on pri-

29. See COMMISSION FOR ENVIRONMENTAL COOPERATION (CEC) TAKING STOCK, NORTH AMERICAN POLLUTANT RELEASES AND TRANSFERS 1996 (1999) [hereinafter COMMISSION FOR ENVIRONMENTAL COOPERATION].

30. The most notable organizations in this area include the Responsible Care (Chemical

vate-sector initiatives is an integral aspect of what has been labeled “ecological modernization.”³¹ To help gauge whether or not such initiatives may pay off in terms of improved environmental performance it will help to more clearly define the limits of first generation environmental policy. These are briefly summarized below under four headings. First, *domain limits* concern what has historically been inside versus outside the regulatory regime’s sphere of concern. Second, *functional limits* focus on bureaucratic systems, flexibility, and the relationship of parts to the whole. Third, *structural limits* concern the emphasis capitalism places on growth in production and consumption. And fourth, *political limits* stem from globalization, capital mobility and shifting relationships of power. As will be pointed out below, EMS initiatives are probably well equipped to deal with the domain and functional limits. But getting beyond the structural and political limits, while not impossible, will be much more challenging.

IV. DOMAIN LIMITS: SHIFTING SPHERES OF CONCERN

When first generation environmental policy was initially drafted many of the new types of environmental problems we face today were not yet in view. Now there are serious gaps in what environmental laws cover. Such gaps cannot be filled with “command-and-control” techniques alone.

Current environmental laws focus almost entirely on manufacturing facilities, especially the larger industries that have historically been the most heavily polluting (e.g., refineries, chemical and power plants, automobile industry).³² Yet, in the case of the U.S., fully seventy-five percent of the economy is in the services sector including telecommunications, health care, banking and insurance industries, among others. The growth associated with today’s “informational economy” is not as blatantly polluting as that of the industrially roaring 1950s and 1960s. But new types of environmental problems have reared their ugly heads. In Southern California, for instance, non-point source pollution running off millions of backyards, farms and streets into (and out of) storm drains has created the biggest environmental threat to the state’s coastline. Other diffuse sources of pollution include emissions from gas stations, dry cleaners, and millions of motor vehicles.

There are other sorts of problems—in addition to non-point source pollution—that were not contemplated by “first generation” environmental

Manufacturers Association), ISO14000 (International Organization for Standardization), GEMI (Global Environmental Management Initiative), and CERES (the Coalition for Environmentally Responsible Economies).

31. See Fred Buttel, *Ecological Modernization and Social Theory*, GEOFORUM, SPECIAL ISSUE ON ECOLOGICAL MODERNIZATION 31 (2000).

32. The CEC notes that in the US and Canada, the top 50 facilities (less than one percent of all those for which data was analyzed) generated almost one-third of total on-site releases of pollution. Pollutants injected or released to land from these sites represented over 70% of the U.S. and Canadian total. Of the top 50 facilities, 29 are chemical industry sites. See COMMISSION FOR ENVIRONMENTAL COOPERATION, *supra* note 29, at 1996.

laws. For instance, today one finds growing concern about the atmospheric build-up of carbon dioxide and other greenhouse gases, the potential environmental impacts of genetically modified organisms, urban sprawl resulting in loss of habitat and bio-diversity, pesticides that might disrupt human endocrine cycles, and the erosion of earth's protective ozone layer in the upper atmosphere. Clearly, other domains beside manufacturing (e.g., transportation, agriculture, services, consumer lifestyles and consumption patterns) will require strategic action. Unfortunately, as researchers at Yale's Center for Environmental Law and Policy, point out: "[t]he command-and-control model is difficult to adapt to the diversity of problems and circumstances—and the concomitant need for a diverse set of tools and government activities at a variety of levels—that we face in the years ahead."³³

V. FUNCTIONAL LIMITS: DESIGNED TO CONTROL VERSES PREVENT

First generation environmental policy has focused on controlling pollution in a highly fragmented pollutant-by-pollutant, industry-by-industry basis. Yet, the complexities of today's environmental problems demands more integrated, pollution preventing and resource conserving approaches (e.g., watershed-based, industrial cluster, and supply-chain programs).

Today's environmental laws, in both the U.S. and Mexico, operate largely on the basis of Federal statutes that specifically limit the amount of pollution that may be put into the air, water, or land. Indeed, most laws, regulations, and environmental agencies have been organized around specific media (air, water and land) or around select material types (pesticides, toxic substances and municipal solid waste). Laws and regulations establishing standards for the responsible use, control and discharge/disposal of these types of material have grown in both number and complexity. Likewise, the logistical, technical and legal difficulties in monitoring and enforcing these rules have also increased dramatically. While some pollutants are heavily regulated, others are not regulated at all. In some cases, effective industry maneuvering has used scientific uncertainty in the regulatory process to delay or counter the establishment and enforcement of standards. The selection of targets and limits often has more to do with power politics (i.e., the purchase of influence) than it does with good environmental science. E. Donald Elliott goes as far to argue that "most of today's environmental law violates the basic principles of ecology. Nature teaches the connected-ness of all activities, but most current-generation law regulates separate pollutants with little consideration of ecosystems as a whole."³⁴

One factor that makes things even more difficult stems from the accelerated speed of product development is today's economy. Development time from product concept to market has dropped from years to months, some-

33. Elliot, *supra* note 28, at 172.

34. *Id.* at 170.

times even weeks. Each new product may introduce new hazardous materials and waste streams that regulators must incorporate into the regulatory structure. As a result, "there is a growing volume of prescriptive regulations that are, at times, conflicting or duplicative, and that have, by necessity, focused both regulated organizations and regulatory agencies almost exclusively on keeping pace with updated regulations and on achieving compliance."³⁵

Gradually, the shift in emphasis from pollution control to pollution prevention will encourage a more integrated and holistic approach to environmental protection. But the progress has been slow in coming. In the case of the U.S., it was not until the U.S. Pollution Prevention Act of 1990 that a formal effort was made to build the concept of prevention into U.S. environmental-protection strategy as a national priority.³⁶ In the case of Mexico, the term "pollution prevention" appears in the General Ecology Law as "pollution prevention and control." This is indicative of the strong influence lingering in Mexico towards the use of abatement technology, such as emissions control equipment, wastewater treatment plants, and treatment and final disposal of solid wastes, rather than the implementation of pollution "prevention" programs.³⁷ Pollution control measures are reactive—typically involving the addition of equipment to remove pollutants that were being released to the natural environment. However, once pollutants are generated they are not easily reduced or eliminated. More often than not they simply change form. The result is a cross-media transfer of pollution (i.e., substances get moved from one environmental medium to another such as from air to water or from water to land, or one community to another). This helps explain why greater emphasis is now being placed on pollution prevention.

There are three policy initiatives that have helped link pollution-prevention theory to action in the U.S. The first is the toxic release reporting requirements that were established in 1986 under Title III of the Superfund Amendments and Reauthorization Act (SARA), otherwise known as the Community Right-to-Know Act. Owing to these reporting requirements, data on actual emissions and releases have become accessible to public scrutiny. This constituted an important step toward rectifying one of the most fundamental shortcomings of first generation environmental policy: a lack of publicly accessible data.

The EPA now maintains a national inventory of toxic releases to the environment (by manufacturing facilities) in a computerized database referred

35. FIRST QUARTERLY REPORT, *supra* note 1, at 4.

36. The 1990 Act was significant in two primary ways. First, it established a national waste management hierarchy that prioritizes pollution prevention (as opposed to pollution control) as the nation's preferred environmental-management strategy (EPA 1997). Second, the 1990 Pollution Prevention Act established a national infrastructure to promote pollution prevention in businesses. This includes an independent office at EPA headquarters for pollution prevention, a national grant program for state efforts in pollution prevention, and a national pollution-prevention information clearinghouse. See University of Michigan, *School of Natural Resources and Environment* (visited May 29, 2000) <<http://www.snre.umich.edu/>>.

37. See Commission FOR ENVIRONMENTAL COOPERATION, *supra* note 29, at 1996.

to as the Toxics Release Inventory (TRI). Access to such data has given some communities leverage to demand corporate accountability and to put pressure on industry to curtail emissions. As Michael K. Heiman has documented,

[w]e now find public protest preventing the siting of new waste management facilities, a resulting rise in disposal costs, increased corporate concern over liability for exposure, and the basic fact that until required to do so by the Right-to-Know legislation, firms rarely conducted the comprehensive audits necessary to see where resources were being squandered as waste discharges.³⁸

Mexico is currently implementing its own version of Right-to-Know Legislation. There is now a National Pollution Release and Transfer Inventory, PRTR (Registro de Emisiones y Transferencia de Contaminantes, RETC).³⁹ Pollutant “releases” are chemicals in waste that are released on-site to air, water, underground injection or land. Pollutant “transfers” are chemicals in waste that are sent from the reporting facility to a facility that treats or disposes of the chemical. Mexico’s PRTR is modeled after the TRI in the U.S. Most data is from manufacturing facilities, especially those producing chemicals, primary metals and paper products. The National Ecology Institute (INE), which operates the PRTR in Mexico, collected data from 500 facilities in 1998, up from fifty in 1997. But the initiative is encountering a number of problems. The effort to more broadly implement the mandatory multi-media PRTR reporting for a wide list of chemicals in Mexico has run up against several constraints. Notably, hazardous waste management policy is still poorly defined, a legal list of chemicals to be reported has not yet been established, and consensus on the degree to which the public should have access to information and data is not yet determined.⁴⁰

Efforts to inform the public about pollution forms the basis for what has become the “third wave” in pollution policy (the first being legal regulation;

38. Michael K. Heiman, *Community Attempts at Sustainable Development Through Corporate Accountability*, 40 JOURNAL OF ENVTL. PLANNING AND MANAGEMENT 631, 634 (1997).

39. Agenda 21, the action plan for sustainable development that came out of the 1992 United Nations Conference on the Environment and Development, recommends that governments and international agencies (in co-operation with industry) develop national data bases and information systems such as toxic releases inventories. Since the adoption of Agenda 21, the United Nations Institute for Training and Research (UNITAR), the Organization for Economic Co-operation and Development and the NAFTA Commission for Environmental Co-operation (CEC), have worked together to guide countries on the establishment of National Pollutant Release and Transfer Inventories (PRTRs). These organizations have assisted Mexico in the establishment of a PRTR. See LGEEPA (visited Feb. 25 2000) <<http://www.ine.gob.mx/dggia/retc/index.html>>. For a discussion of the challenges of establishing such community-right-to-know legislation. In Mexico, see Donovan Corliss, *Regulating the Border Environment: Toxics, Maquiladoras, and the Public Right to Know*, in SHARED SPACE: RETHINKING THE U.S.-MEXICO BORDER ENVIRONMENT 295 (Lawrence A. Herzog ed., 2000).

40. See COMMISSION FOR ENVIRONMENTAL COOPERATION, *supra* note 29, at 1996.

the second, market-based instruments).⁴¹ The level of investment in information strategies is likely to rise. There are a number of reasons for this. Rising benefits and falling costs (to collect, aggregate, and disseminate information), coupled with times of fiscal austerity are bound to make information strategies an attractive method to complement regulatory efforts. Indeed, in both Mexico and the U.S. significant emphasis is being placed on developing such strategies. The U.S.-Mexico Border XXI program, for instance, has an Information Working Group that is identifying what information already exists, systematizing its availability, and defining ways to deliver information more effectively to border communities.

NAFTA-driven legal-institutional initiatives such as the North American Agreement for Environmental Cooperation (NAAEC) emphasize the importance of pollution prevention as an environmentally and economically effective alternative to pollution control.⁴² The Council of the Commission for Environmental Cooperation (CEC), created as a result of the NAAEC, has developed a number of recommendations regarding pollution prevention techniques and strategies.⁴³ The CEC defines pollution prevention as activities that benefit the environment through source reduction of waste and/or emissions; improved efficiency in the use of resources and inputs; and elimination/reduction in the use of environmentally harmful substances or activities. The CEC finds that pollution prevention is becoming the principal environmental paradigm in North America today.⁴⁴ The CEC stresses that "as a key element in the implementation of sustainable development, pollution prevention requires the involvement of all types of business and non-business activity, and must become the dominant strategy for addressing non-point, as well as point sources of pollution."

The CEC (1996) reports that most of the companies that have established pollution prevention programs in Mexico are large subsidiaries of international corporations that have based their programs on the principles and

41. See Tom Tietenberg, *Information Strategies for Pollution Control*, paper presented at the Eighth Annual Conference of the European Association of Environmental and Resource Economists, Tilburg University, The Netherlands, June 26-28, 1997.

42. The NAAEC creates a North American framework whereby goals related to trade and the environment can be pursued in an open and cooperative way. See *North American Commission for Environmental Cooperation* (visited May 29, 2000) <<http://www.cec.org>>.

43. The CEC's mission is to address regional environmental concerns, help promote environmental law enforcement, and help prevent potential trade and environmental conflicts. Securing public participation in each of these efforts is considered a high priority. See *id.* For a discussion of CEC's views on ISO 14001, see Jason Hart, *A Bold, New EMS Standard for North America?*, INTERNATIONAL ENVIRONMENTAL MANAGEMENT SYSTEMS UPDATE, Vol. 6, No. 5, p. 12. (May 1999).

44. Local, state and federal interests in the U.S. joined forces to establish the National Pollution Prevention Roundtable (NPPR) as a forum for exchanging pollution prevention experiences and lessons. NPPR is the largest membership organization in the U.S. devoted solely to pollution prevention; it provides a global forum for promoting the development, implementation, and evaluation of efforts to avoid, eliminate or reduce pollution at the source. See *National Pollution Prevention Roundtable* (visited May 29, 2000) <<http://www.p2.org/index>>.

administrative practices of their parent corporations. Yet, even as these large companies make the necessary investments to improve their environmental performance, many small and medium sized enterprises (SMEs) have hardly begun to establish pollution prevention programs.⁴⁵ As a rule, SMEs are more preoccupied with pollution control and compliance with environmental regulations than they are with pollution prevention. Taking this fact into account, the World Bank recently funded a major pilot project in Guadalajara where the objective was to enable large firms to collaborate with (i.e., mentor) their SME suppliers on environmental management and pollution prevention strategies (Ahmed, Martin and Davis 1998).

Although awareness of the importance of pollution prevention is growing within industry throughout the NAFTA region, there is still a long way to go. The CEC (1996) reports that pollution-prevention initiatives are too frequently scattered and uncoordinated. Many NAFTA-region industries still fail to perceive pollution prevention as an opportunity for business improvement. In the U.S., the concept of pollution prevention is fairly well established in many companies, but these companies still make up only a small percentage of U.S. businesses. One of the reasons that regulatory innovation initiatives are so important is that they look for the functional limits impeding the adoption of pollution prevention methods on a more extensive basis. It is on this point that the strategic focus on EMSs seems so promising. But there are additional structural and political limits with which to contend.

VI. STRUCTURAL LIMITS: GROWTH MACHINE EXTERNALITIES

It is not the within the mandate of first generation environmental policy to question economic growth. Yet, the environmental externalities associated with unbridled growth are increasingly problematic. Indicators, methods and policies to discern meaningful differences between growth and development are sorely lacking.

There can be no denying that today's emphasis on pollution prevention marks an important shift toward more proactive and systems-based approaches. At the same time though, it is important to also realize that conceptualizing environmental problems primarily in terms of pollution can be misleading. Nations that have made the most progress toward "solving" (at least the most evident) pollution problems are the most affluent and resource-intensive. All things taken into account, richer nations tend to exact a far greater toll on the environment than do developing nations such as Mex-

45. The Lexington Group did a survey of environmental management systems and found that 70-80% of large Mexican and multinational companies in Mexico had EMS elements in place as opposed to fewer than 20% of Mexico's smaller companies. See LEXINGTON GROUP, INDUSTRIAL ENVIRONMENTAL MANAGEMENT IN MEXICO: REPORT ON A SURVEY, submitted to the World Bank, September 11, 1996; see also Susmita Dasgupta, Hemamala Hettige & David Wheeler, *What Improves Environmental Performance? Evidence from Mexican Industry*, Development Research Group, World Bank, Working Paper Series #1877.

ico, Colombia or Thailand. A recent study of Germany, Japan, the Netherlands, and the U.S. documents the immense volume of natural resources required to run a developed economy—in the range of forty-five to eighty-five metric tons of material per person each year.⁴⁶ Much of this material flow—including mine tailings, eroded soil, logging debris, and excavated earth and rock—does not end up in final products. The staggering tonnage of such flows accounts for as much as seventy-five percent of the total materials used in industrial economies.⁴⁷ Given that such flows do not enter the economy as commodities they are not accounted for in national gross domestic product. This omission is problematic in so far as it impedes accounting for the massive scale of environmental alteration and externalities associated with such flows. And given the globalization of the economy, the resulting impacts of these flows (e.g., watershed pollution, habitat degradation) often register in poorer countries far from the developed economies that benefit most from the process.

As the field of ecological economics matures we may expect greater insights from the field of green accounting. Indeed, the World Bank recently published a report titled “Redefining the Wealth of Nations.” The World Bank’s report, which advances a method for assigning value to natural capital and environmental services suggests that the ecological critique of mainstream economics has registered—at least in theory. But the challenge ahead is a formidable one, especially in light of intergenerational equity. One author points to the difficulty in these terms:

The ecological critique of mainstream economics is based on the question of unknown future agents’ preferences and their inability to come to today’s markets, and therefore on the arbitrariness of the values given at present to exhaustible resources or to future social and environmental costs. This critique is also based on uncertainty about the workings of environmental systems, which prevents the application of externality analysis: we do not know about many externalities, and concerning some externalities about which we *do* know, we do not even know if they are positive or negative (or *for whom* they are positive or negative in their effects). Certainly, we are far from being able to give to them a monetary present value.⁴⁸

If it is necessary to take environmental externalities into account and do a better job distinguishing between growth and development, then traditional

46. See A. ADRIAANSE, ET AL., *RESOURCE FLOWS: THE MATERIAL BASIS OF INDUSTRIAL ECONOMIES*, a joint publication of the World Resources Institute (WRI); the Wuppertal Institute; the Netherlands Ministry of Housing, Spatial Planning and the Environment; and the National Institute for Environmental Studies iv (Washington, D.C., 1997).

47. See WORLD RESOURCES INSTITUTE, ET AL., *1998-1999 WORLD RESOURCES, A GUIDE TO THE GLOBAL ENVIRONMENT: ENVIRONMENTAL CHANGE AND HUMAN HEALTH* 161 (1999) [hereinafter WRI ET AL].

48. Juan Martínez Alier, *Ecological Economics and Ecosocialism*, in *IS CAPITALISM SUSTAINABLE: POLITICAL ECONOMY AND THE POLITICS OF ECOLOGY* 23 (Martin O’Connor ed., 1994).

environmental policy leaves much to be desired. Even where an emphasis on pollution prevention draws attention to environmental racism or other social justice and equity issues, there is still an inadequate accounting of how overall materials and resource use continues to grow at a global scale each year. For instance, global paper consumption has tripled over the past three decades and is expected to grow half again before 2010.⁴⁹ The global economy as a whole is expected to grow four or five-fold over the next fifty years. Even as the regulation of hazardous waste and toxic substances grows, the generation of these wastes and the production of toxic chemicals is expected to continue growing as well.⁵⁰ The current regulatory approach has a limited ability to reduce the overall use and generation of these substances. The global economy's largely one-way throughput of material and energy (resources in, waste out) is on an upward, even if very uneven, spiral. This demands new approaches to environmental protection and restoration.

A recent study released by the CEC documents some progress. The release and transfer of certain major forms of industrial pollution in the U.S. and Canada decreased by 2.3% over the period 1995-1996.⁵¹ This is good news. But it must be noted that the CEC's report draws its information from the 1996 TRI in the U.S. and the National Pollutant Release Inventory in Canada. Such inventories primarily focus on manufacturing and therefore can only provide a partial picture of pollution released. Missing from the picture (as mentioned in the above section on domain limits) are non-point source pollutants such as farms (which use pesticides and chemical fertilizers), small businesses (such as service stations and dry cleaners), and mobile sources of pollutants, including cars, trucks or boats. Yet these sources, and their unintended environmental consequences, constitute some of the most pressing problems at the dawn of the new millenium.

Of course, preventing pollution is crucial. But closing the loop on the throughput of material and energy resources, while addressing challenges posed by growth, eco-system interdependencies and carrying capacity, presents an equally daunting task. Such concerns lie at the heart of emergent approaches under various headings including industrial ecology, eco-efficiency, source reduction, and the greening of industry. Such approaches look for ways to incorporate pollution prevention into activities that already influence business decision-making. Regulatory innovation focused on EMSs lays an important foundation for promoting these new approaches. EMSs promise to expand the scope of environmental decision-making beyond plant managers to also include design engineers, process engineers, marketing personnel and accountants, as well as other stakeholders outside the firm (e.g., community groups). If such efforts are built into global networks of production and consumption, then more opportunities to make de-

49. See WRI ET AL, *supra* note 47, at 161.

50. See COMMISSION FOR ENVIRONMENTAL COOPERATION, *supra* note 29, at 1996.

51. See *id.*

velopment less throughput intensive may be realized. Unfortunately, despite all the rhetoric advocating "sustainable development," the defining success of global capitalism is still measured in terms of growth (i.e., progress is equated with higher and higher levels of GNP). Any effort to curb the environmental externalities spit out by capitalism as a growth machine par excellence ultimately becomes political. In this light, it is important to consider the political limits of traditional environmental policy. Insight along these lines sheds light on how EMSs and regulatory innovation may best come into play.

VII. POLITICAL LIMITS: ECONOMIC GLOBALIZATION AND SHIFTING RELATIONSHIPS OF POWER

Economic globalization and liberalization have shifted relationships of power among transnational corporations, nation states, regions, and non-governmental organizations. In this new global economy, innovation is needed not only in technical and informational systems, but also in systems of governance that transcend national borders and go beyond what first generation environmental policy was set up to accomplish.

With respect to addressing the challenges posed by environmental problems, much ink has been spilled in critique of mainstream politics as the product of liberal democracy and the administrative state. For instance, John S. Dryzek characterizes the limits of state administrative systems as three-fold. First, these systems are highly constrained in their ability to respond to problems. While hierarchy and bureaucratic organization certainly bestow benefits, the costs often include less flexibility in response type and timing. Second, administrative rationality has a hard time with multifaceted and complex problems. Problem disaggregation through administrative division of labor often sets up artificial boundaries that make integrated approaches difficult. Third, hierarchy inherent in administrative systems tends to constrain the free transmission of information up and down lines of command. Hierarchical authority sometimes prevails over good argument and makes institutional learning through decentralized problem-solving difficult.⁵²

The kinds of political limitations described by Dryzek are rough generalizations. An understanding of administrative systems and governance in today's increasing global economy is complicated task. Looking back, first generation environmental policy in the U.S. had its genesis during the Nixon Administration. The prevailing administrative system of the time was referred to as "cooperative federalism." In this system, the center issues commands to regional nodes for implementation. Today, this approach is derided as "unfunded federal mandates" and there is mounting pressure for the decentralization, deregulation, and privatization.⁵³ Along similar lines in Mex-

52. See generally John S. Dryzek, *supra* note 48.

53. Elliot, *supra* note 28, at 172.

ico, the capacity of the central state has diminished. These trends in and of themselves are not what is problematic. Indeed, if a new decentralized regionalism comes out of it, this may augur well for environmentalism. The problem lies in the way relationships of power among transnational corporations (TNCs), nation states, regions, and non-governmental organizations have shifted in the process.

Over the past fifteen years the merits of capital account liberalization and privatization have been trumpeted around the world. In the process many valuable national assets have shifted from government control to the private sector. And there appears to be a growing concentration of power in the world's largest TNCs.⁵⁴ The context provided by neo-liberal globalization challenges the ability of states to shape markets.⁵⁵ First generation environmental policy shaped markets by directly restricting the rights of producers and consumers to do environmental harm and by penalizing polluters. Now, such direct intervention is no longer the principal method of choice. Indeed, direct intervention is increasingly frowned upon.

Hyper-capital mobility in the world economy has made governments skittish about market intervention for any purpose other than promoting growth. Those national, regional, or city governments that do attempt to construct market rules for explicit social and/or environmental purposes risk the consequences of capital flight or restricted access to capital. The rules of international trade—governed by agreements under the World Trade Organization (WTO)—have enhanced the mobility of global capital and the shift in power from states to TNCs.⁵⁶ This “global shift” is having a profound impact on the organization of political and economic systems worldwide. As Peter Dicken describes it, “national boundaries no longer ‘contain’ production processes in the way they once did. Such processes slice through national boundaries and transcend them in a bewildering array of relationships that operate at different geographical and organizational scales.”⁵⁷ Increasingly, TNCs play the key role in co-coordinating what have become globe-girdling production chains. This gives TNCs the upper hand in shaping the new global economy.

Governments and regulators no longer have the same level of control they once had over their national economies. And corporate elite around the world are quick to assert that—if it is to be effective—any management of economic processes has to be done in cooperation with business. While such an assertion has merit in many respects, the growth and globalization of business has not been accompanied by a comparable growth in the globaliza-

54. See generally BENNETT HARRISON, *LEAN AND MEAN: THE CHANGING LANDSCAPE OF CORPORATE POWER IN THE AGE OF FLEXIBILITY* (1997).

55. See Evans, *The Eclipse of the State? Reflections on Stateness in an Era of Globalization*, *WORLD POLITICS* 50, 62-87 (Oct. 1997).

56. See generally DAVID C. KORTON, *WHEN CORPORATIONS RULE THE WORLD* (1995).

57. PETER DICKEN, *GLOBAL SHIFT: TRANSFORMING THE WORLD ECONOMY* 7 (3d ed. 1998).

tion of governance and democracy. In some ways, the collective power of corporate elite (as expressed through investment, disinvestment and the purchase of influence) exceeds the power of any democratically elected institution. For this reason, the effective mobilization of civil society at local, regional, national and ultimately global levels has an especially crucial role to play. Tensions between global corporate culture and the mobilization of global civil society can be seen in recent opposition to the Multilateral Agreement on Investment (MAI). In February 1998 over 600 civil society organizations (NGOs) from sixty-eight countries submitted a joint letter to the OECD outlining their grave concerns about the scale of economic instability and social and environmental disruption created by the increasing mobility of capital. Their widely circulated letter calls for the proactive regulation of international investments.⁵⁸ The social protests in Seattle, in conjunction with the 1999 meeting of the World Trade Organization (WTO), is further evidence of the discord between elements of civil society and corporate interests determined to quicken the pace and reach of global trade liberalization.

Theories developed within the framework of strategic management, organizational, and innovation studies suggest that public pressures have been among the most important driving forces for changes in firm behavior.⁵⁹ Such theory suggests that the mobilization of environmental NGOs has contributed to a new kind of social interaction and learning process among firms and the public.⁶⁰ Environmental protection now requires the creation of new networks and learning processes among a variety of stakeholders including business, academic, public and non-governmental entities.⁶¹ First generation environmental policy is simply not tailored to meet such requirements. But the recent emphasis on EMSs as a means for regulatory innovation is promising along these lines.

The next section of this paper briefly describes three EMS initiatives, one in the U.S. and two in Mexico. These cases will be used to reflect on the following two questions. To what extent will EMS-driven regulatory initiatives be able to overcome the kinds of domain, functional, structural and political limits described above? And, in light of these initiatives, what are the most pressing issues for research and action in the San Diego-Tijuana global city-region?

58. *See generally* AD HOC WORKING GROUP ON THE MAI, 1998 MAI: DEMOCRACY FOR SALE? (1998).

59. *See generally* KURT FISCHER & JOHAN SCHOT, ENVIRONMENTAL STRATEGIES FOR INDUSTRY: INTERNATIONAL PERSPECTIVES ON RESEARCH NEEDS AND POLICY IMPLICATIONS (1993).

60. *See generally* ROBERT GOTTLIEB, REDUCING TOXICS: A NEW APPROACH TO POLICY AND INDUSTRIAL DECISIONMAKING (1995).

61. *See generally* PETER GROENEWEGEN, KURT FISCHER, EDITH G. JENKINS & JOHAN SCHOT (EDS.), THE GREENING OF INDUSTRY RESOURCE GUIDE AND BIBLIOGRAPHY (1996).

VIII. THE MULTISTATE WORKING GROUP (MSWG)

In the U.S., a Multi-State Working Group (MSWG)—including representatives from government, industry, NGOs and academic/research institutions—has been formed to examine the potential benefits (and limitations) of EMSs, notably ISO14001. The MSWG won the 1998 *Council of State Government's Innovation Award*. It is currently developing a national research strategy and database, to include EMS information.⁶² Recently, a Southern California Working Group was formed to facilitate the research and data collection efforts in Southern California.

The MSWG's national strategy is being designed to meet the data needs of business, government and public interest parties that want to improve environmental performance. The process has a three pronged approach:

Create a national database for EMS-generated performance information. The EPA and MSWG are sponsoring over 100 EMS and ISO 14000 pilot projects from around the country to populate the database.

Hold Roundtables: MSWG has adopted a strong relationship with university researchers. In 1998, MSWG conducted six academic research roundtables involving faculty from thirty-eight colleges and universities that identified 150 EMS research topics.⁶³

Sponsor Research Summit: MSWG sponsored a national EMS Research Summit at the Brookings Institution in Washington, DC. Summit participants aimed to collaboratively compose an EMS research agenda that meets business, government and public interest group needs, plus the structure and process to manage the agenda.⁶⁴

The EMS Research Summit, hosted by the Brookings Institution on November 2-3, 1999 brought together experts, academics and practitioners looking for ways to enhance the creation, integration, and transfer of knowledge about EMS. The Summit tackled a huge task in its coverage of research, including such important questions as: How are companies developing and implementing environmental management systems? How are they used? What economic and environmental benefits do they convey, and how are they measured? How can business partner with citizens to ensure that stakeholder interests are addressed? What are the global impacts?

Building on the success of the Brookings Summit, the MSWG, together with the California EPA and the Pacific Institute, will host a national EMS conference in San Diego during June 2000. Among other topics, the confer-

62. On July 22-23, 1999, the U.S.-EPA and the MSWG hosted a national workshop titled, "Learning Together: EMSs, Environmental Performance and Regulatory Innovation." See Learning Together: Environmental Management Systems, *Environmental Performance and Regulation Innovation* (visited Feb. 28, 2000) <<http://www.dep.state.pa.us/dep/deputate/pollprev/mswg/learning.htm>>.

63. See *id.*

64. See *The Counsel of State Governments* (visited Feb 28, 2000) <<http://www.statesnews.org/clip/policy/htm>>.

ence planning committee expects to cover pilot project case studies, EMS in municipalities, supply chain EMSs, the role of universities and international issues. As stated in the introduction to this paper, the MSWG is the most significant research-driven environmental policy initiative in the U.S. today. Its emphasis on EMSs sets the stage for advancing a two-tier (or two track) regulatory system, tier one focusing on compliance and penalties, tier two focusing on performance and incentives. The rationale motivating this initiative is captured well in the following quote:

[i]t is widely recognized that command and control alone cannot and will not move society to the next level of progress in protecting human health and ecological resources. Open, inclusive, information-rich, and incentive-based environmental management systems can address many unmet needs and achieve superior results. However, a general lack of awareness, bureaucratic resistance, disempowerment, and distrust have prevented their widespread adoption. The new approach calls for transparency, participation, shared responsibility, and demonstrable improvement. Catalyzing the transition to a proactive, dynamic ecological consciousness will require building awareness of its potential benefits, educating people in the public and private sectors on how it can work, and motivating organizations and individuals to put it into operation. In short, it will require leadership.⁶⁵

The MSWG's leaders are looking for ways to enhance the creation, integration, and transfer of knowledge throughout a growing EMS network of individuals and organizations. The MSWG and the Council of State Governments now has a plan in the works to establish an EMS Policy Academy. The primary functions of the Academy will be to:

train state, national or business sector teams and NGOs on methodologies and protocols related to EMS development, implementation, assessment, and operation;

conduct research, dialogue and information sharing programs on environmental management systems and the resources, monitoring strategies, oversight systems, and empowerment processes which support them;

provide post-training technical assistance, technology transfer and other support for targeted national and international EMS programs and pilot projects.⁶⁶

The work of the MSWG and the prospective EMS Policy Academy shows great potential with respect to building capacity for EMS research, education, training, and outreach. It is anticipated the Academy's training

65. THE COUNCIL OF STATE GOVERNMENTS AND THE MULTI-STATE WORKING GROUP ON ENVIRONMENTAL MANAGEMENT SYSTEMS, WHITE PAPER ON THE DEVELOPMENT OF A POLICY ACADEMY ON ENVIRONMENTAL MANAGEMENT SYSTEMS 2 (1999) [hereinafter WHITE PAPER].

66. *Id.* at 3.

programs will eventually expand beyond the U.S. The intent is to develop courses that will take place in Asia, Eastern Europe, the New Independent States, and Latin America (notably Mexico).

Mexico's Ministry of Environment, Natural Resources and Fisheries (*Secretaría de Medio Ambiente, Recursos Naturales y Pesca*, SEMARNAP) and the Attorney General for the Environment (*Procuraduría Federal del Protección al Ambiente*, PROFEPA) have incorporated a voluntary certification program into its regulatory system. Companies that get certified can advertise themselves as *Industria Limpia* (Clean Industry). To get certified, an organization must undergo a comprehensive audit that identifies potentially hazardous environmental and workplace conditions. The Clean Industry audit covers non-regulated as well as regulated aspects of environmental performance. The program is distinct from the ISO 14001 EMS in that it provides only a snap shot view of environmental performance; it does not require the implementation of an ongoing system geared to continual improvement.

During July 1997, the Mexican government showcased the *Industria Limpia* program in Tijuana during a major exposition they billed as "ECO TIJUANA INDUSTRIAL." Thirty-seven companies—sembled from all different parts of Mexico—put their environmental investment strategies on display at this exposition. Some of the companies were certified to the *Industria Limpia* standard; others (e.g., Sony Tijuana) have ISO 14001 certification. SEMARNAP collaborated with the U.S. EPA and the U.S./Mexico Chamber of Commerce to promote seven "voluntary principles of sound corporate environmental stewardship."⁶⁷

A large nationwide survey of the environmental management practices of Mexican industry was conducted in 1995 by staff from the *Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM). The study found evidence that there is a significant correlation between higher levels of environmental performance and the adoption of elements of an EMS. The Lexington Group, which wrote-up the results of the survey, concluded that improved EMSs will: (1) more fully integrate environmental considerations into facility decision-making, (2) give greater priority to environmental issues, and (3) identify more cost-effective activities to improve performance. At the same time, the Lexington Group notes that "there exists a critical need to develop simple management approaches that can be applied by small companies."⁶⁸ Smaller firms are less likely to have elements of an EMS in place. The World Bank and Mexican government sponsored a survey of the environmental management capabilities in Mexico in four sectors, involving 250 companies of different sizes. Of all the large companies examined in

67. *U.S.-Mexico Border XXI Frontera XXI: U.S./Mexico Business and Trade Community: The Seven Principles of Environmental Stewardship for the 21st Century* (visited Nov. 8, 1999) <<http://134.67.55.16.7777/R9/MexUSA...52231882567a00000c441>>.

68. LEXINGTON GROUP, INDUSTRIAL ENVIRONMENTAL MANAGEMENT IN MEXICO: REPORT ON A SURVEY xiii (Sept. 11, 1996).

this survey, 70-80% had some elements of an EMS in place. Only about 20% of small companies had similar elements in place.

The degree to which ISO14001 is an appropriate EMS model for implementation by SMEs was the subject of inquiry in the Guadalajara Environmental Management Pilot (GEMP). The GEMP EMS/SME pilot project began during late 1996. It brought together collaborators from the World Bank, Mexican government, standard setting and regulatory agencies, large companies, SME suppliers, international consultants, and experts from universities. The objectives were threefold: to promote the use of voluntary environmental management systems in industry in Mexico; to measure the benefits and difficulties in implementing the systems, and to develop networks and capacities to replicate the systems and benefit others.⁶⁹

With support from the World Bank, the GEMP focused on eleven major Guadalajara-based production companies that agreed—in a written accord with SEMARNAP—to provide EMS assistance to up to three of their (SME) suppliers. The selected SMEs and large companies spanned a mix of sectors: textiles, electronics, machinery, food, chemicals, among others. The Lexington Group was selected as the project consultant. These consultants subcontracted and worked with people from two local universities to help with training and implementation. The World Bank also hired social scientists to investigate whether or not any cultural change happened inside the companies as a result the intervention.

Given the paucity of knowledge in this field, the GEMP provided an important benchmark in the study of EMS networking and collaboration. Most of the literature on industrial greening takes the form of descriptive case studies presented in a journalistic fashion (Gladwin 1993). The bulk of the literature lacks an adequate theoretical grounding or rigorous methodology. At the same time, most of the studies focus on developed countries and, until recently, very little has been available on developing countries. All of this underscores the significance of the GEMP. One of the World Bank's principal organizers of the GEMP, Kulsum Ahmed, summarized some key findings in response to several questions:

They had decided to use ISO14001 as the model EMS, but was this the appropriate choice? Yes, the small and medium size companies did not find this too complex . . . they understood it and could manage with it.

Do networks work for SMEs? Can the mentoring skills and increased capabilities of the large companies be effectively leveraged? Yes, the expansion of the networks coming out of this program that are no longer supported by [World Bank] . . . funds are a good demonstration of the success of this networking activity.

69. See SEMINAR, COLLABORATING FOR COST-EFFECTIVE POLLUTION MANAGEMENT: A PUBLIC-PRIVATE SECTOR DIALOGUE, Washington D.C. (Oct. 26-28, 1998).

Does the EMS improve environmental performance? Yes, many examples were given of how it has helped⁷⁰

Kulsum Ahmed also found that one of the GEMP's key successes stems from how it helped differing factions within Mexico's Ministry of Environment recognize common objectives, and how it enabled these agencies to appreciate the value of voluntary EMSs and collaborative public-private sector action.

The MSWG, the *Industria Limpia* program, and the GEMP each seek new approaches for environmental protection and restoration. Each recognizes that progress in the new millennium requires proactive and integrated systems that move beyond conflict. Each aims to harness the potential embodied in management innovation, community involvement, information technology, and emerging incentives for the greening of industry. Such initiatives thus constitute important advances necessary to get beyond the limits posed by traditional environmental policy. As the MSWG and U.S. Council of State Governments points out:

[t]he process of regulation development, promulgation and implementation is rife with controversy, expensive, and unable to address many of the regional and global challenges of the 21st century. The adversarial relationships fostered by the existing oversight system have led to legal wrangling, political posturing and specious jobs vs. the environment disputes that waste resources and accomplish little in terms of environmental improvement.⁷¹

In this light, the move toward comprehensive environmental management is a promising development. What does all of this suggest as far as the San Diego-Tijuana global city-region is concerned? What kind of agenda does this suggest for research and practice?

IX. EMSS AND THE SAN DIEGO-TIJUANA GLOBAL CITY REGION

The internationalization of the global economy and the North American Free Trade Agreement (NAFTA) has fueled strong industrial growth along the U.S.-Mexico border. During a recent talk she gave in San Diego, Mexico's Foreign Affairs Minister, Rosario Green, emphasized how dramatically the pace of border commerce has increased during the past several years: "[i]n 1997, Mexico became California's second largest export market, and 21.5% of its exports in 1998 were NAFTA related."⁷² In the same year, "total trade through the five ports of entry along the California-Baja California

70. Kulsum Ahmed, Environmental Specialist, Latin America and Caribbean Region, World Bank, summary given at a seminar titled, *Collaborating for Cost-Effective Pollution Management: A Public-Private Sector Dialogue*, Washington D.C. (Oct. 26-28, 1998).

71. WHITE PAPER, *supra* note 65, at 1.

72. Lindsey Robinson, *Envoy Says Mexico-U.S. Links Embrace Law, Trade*, SAN DIEGO DAILY TR., Apr. 27, 1999.

border amounted to more than \$22 billion. This represents almost 17% of total trans-border trade."⁷³ One port of entry in San Diego (San Ysidro) is now "the single busiest border crossing point in the world."⁷⁴

Of the border region's fourteen binational sister city pairs, the San Diego-Tijuana (SD-TJ) pair is the most populated and rapidly growing. The SD-TJ region provides a gateway to the Pacific; as such it has become a nodal point in the expanding trade among Pacific Rim countries. Its combined population grew from 3.6 million in 1990 to more than 5 million by the year 2000, with the fastest growth occurring in Tijuana. The rapid urban and industrial growth on both sides of the border has generated a number of increasingly serious environmental problems. Chief among these are the over-exploitation and contamination of transborder ground and surface water resources and the lack of proper disposal or recycling of liquid, solid and hazardous waste. The seriousness of these problems combined with recently heightened civic awareness have helped focus binational attention on hazardous waste monitoring, environmental management, risks and impacts, as well as on pollution prevention and remediation. A host of new agencies including, among others, the Border Environmental Cooperation Commission, the North American Commission on Environmental Cooperation, and the U.S.-Mexico Border Health Commission have joined several existing federal and state level agencies to address environmental pollution and health.

A wide range of hazardous substances is used in industrial production along the border. Among other things there are solvents containing organic compounds, acids, and heavy metals. The mishandling of these substances inside factories represents a health risk for some workers and threatens public safety in surrounding neighborhoods. In the case of Tijuana, which is contiguous with San Diego, there is concern about the increasing risk for environmental emergencies arising from the improper management of hazardous substances, human error, and/or equipment failure. As Roberto Sanchez points out,

industrial emergencies are of particular concern in Tijuana because of the widespread distribution of industrial plants throughout the city, the shortage of information regarding what kinds of hazardous substances are housed in each plant, and the limited local resources for training and equipping emergency staff to deal with these kinds of events.⁷⁵

Pollutants released in Mexico are often transported by air or water north of the border. Pollution also flows from north to south—both via natural media and by illegal export. During the 1980s, northern Mexico (especially Tijuana) became the favorite site for the illegal dumping of hazardous

73. *Id.*

74. *Id.*

75. Roberto Sanchez, *Sustainable Development in Tijuana: A Perspective on Options and Challenges* 53 (available at Center for U.S.-Mexican Studies: La Jolla, California).

wastes.⁷⁶

With respect to the U.S.-Mexico border, the fact that the requisite cooperation among business, public, university and non-governmental organizations must take place across an international boundary complicates matters. While Mexico and the U.S. share a high degree of economic integration, they are the most unequal pair of rich and poor neighboring countries anywhere in the world.⁷⁷ There is a pressing need to create new working relationships among researchers, NGOs, government officials and industry professionals. Building such relationships through Internet linkages, and, more importantly, through face-to-face professional and community contact, will encourage mutually reinforcing interaction, learning and innovation. Jane Fountain explains how

[m]any firms, industries, and regions that are currently successful have formed productive collaborative relationships with a variety of other firms, laboratories, universities, and governments at both state and federal levels in order to leverage the benefits of cooperation. These benefits include shared resources, shared staff and expertise, group problem solving, multiple sources of learning, collaborative development, and diffusion of innovation.⁷⁸

The promotion of EMSs can facilitate and leverage this type of networking in the San Diego-Tijuana region. Along such lines, the San Diego-Tijuana Industrial Ecology Group developed a project proposal dubbed STEP (Sustainability Through EMS Partnerships). The proposed STEP project builds on lessons learned from the GEMP described above.⁷⁹ The primary goal is to identify an approach to promoting environmental sustainability in the U.S.-Mexico border region through the use of EMSs and supply-

76. See Dean E. Carter, Carlos Peña, Robert Varady, & William A. Suk, *Environmental Health and Hazardous Waste Issues Related to the U.S.-Mexico Border*, 104 ENVIRONMENTAL HEALTH PERSPECTIVES 6 (June 1996); see also Kate O'Neill, *In Focus: Hazardous Waste Disposal*, 4 FOREIGN POLICY (Jan. 1999).

77. See RAUL HINOJOSA-OJEDA, *THE NORTH AMERICAN DEVELOPMENT BANK* (1995); see also Roberto Sanchez, *Urban Growth and the Environment of Tijuana*, in SAN DIEGO-TIJUANA IN TRANSITION: A REGIONAL ANALYSIS 77 (Norris C. Clement & E. Zepeda Miramontes eds., 1993).

78. Jane E. Fountain, *Social Capital: A Key Enabler of Innovation*, in INVESTING IN INNOVATION: CREATING A RESEARCH AND INNOVATION POLICY THAT WORK 85 (Lewis M. Branscomb & James H. Keller eds., 1998).

79. See THE WORLD BANK'S MEXICO DEPARTMENT AND THE ENVIRONMENTALLY AND SOCIALLY SUSTAINABLE DEVELOPMENT SECTOR MANAGEMENT UNIT, LATIN AMERICA AND THE CARIBBEAN REGIONAL OFFICE, *THE GUADALAJARA ENVIRONMENTAL MANAGEMENT PILOT*. (Report No. 18071-ME, September 8, 1998), available on *New Ideas in Pollution Regulation* (visited May 29, 2000) <http://www.worldbank.org/nipr/work_paper/guada/>. The study was designed to address three key policy questions: (1) Is the ISO 14001 EMS model appropriate for implementation by SMEs?; (2) Are networks among SMEs, large companies, universities, and government agencies effective mechanisms to promote implementation of EMSs by SMEs?; (3) Does an EMS improve the environmental performance of SMEs, and can the EMSs initiated through the Pilot be sustained? *Id.*

chain partnerships. The research component of the STEP project will document lessons learned and contribute to theory-building in the emergent field of industrial ecology. The project will identify and assess the cultural, business, and regulatory conditions that promote or detract from the phenomenon of large corporations sponsoring and mentoring smaller corporations in environmental compliance, with specific focus on EMS. Specific objectives of the STEP project are listed below:

(1). Begin building a comparative U.S.-Mexico case study database that illustrates the economic as well as legal-institutional opportunities and constraints associated with EMS implementation and networking;

(2). Identify and explain the barriers and bridges to the integration and transfer of knowledge about EMSs;

(3). Model the development of EMS informational systems as they relate to supply chain partnerships and industrial clusters in a cross-border and comparative context;

(4). Identify "best practices" that address ISO 14001 requirements for large firms and their small suppliers; and,

(5). Identify business, cultural, and community benefits obtained through the development of EMSs.⁸⁰

Given the internationalization of the global economy and the increasing importance of global city-regions in the world's new competitive landscape, effective networking and collaboration at a regional level has become an increasingly important factor in sustaining competitive advantage. But as the organizers of a recent conference on global city-regions ask: "[h]ow can social well being and environmental quality be secured in global city-regions when these often seem to be endangered by increasing urbanization and globalization?"⁸¹ In this paper, the case has been made that EMSs may offer one way to approach this challenge. The STEP proposal is offered here as a model for the kind of research and practice that merits support. In the broader scheme of things, however, the collective success of EMSs ultimately depends on how they are linked to the dynamics driving urban and regional development.

CONCLUSION

We now recognize that non-environmental actors, not the EPA or its state counterparts make the majority of environmental decisions. Environ-

80. The STEP proposal was co-authored, January 1999, by Keith Pezzoli, Kathy Kopinak, Greg Lorton, Walter Platkus, and Jennifer Kraus. Copies can be obtained by e-mail from kpezzoli@ucsd.edu. Funding is currently being sought.

81. Allen J. Scott, John Agnew, Edward W. Soja, & Michael Storper, *Global City-Regions*, Conference Theme Paper for Global City-Regions conference, Los Angeles (October 21-23, 1999) hosted by the UCLA School of Public Policy and Social Research, available at *Global City-Regions Conference: Papers and Abstracts* (visited May 29, 2000) <<http://www.spsr.ucla.edu/globalcityregions/Abstracts/abstracts.html>>.

mental quality depends fundamentally on choices made in transportation, agriculture, energy use, land use and on matters of international trade and competitiveness. Today's critical "environmental" decision makers include mayors, transportation system designers, route planners for overnight packaging companies, energy marketers, farmers, and trade negotiators. We thus need a "systems" approach to policy built on a strong social as well as natural science base, rigorous analysis, and an interdisciplinary framework for collaboration. EMS initiatives, while promising in their potential to address the limits of traditional environmental policy, still can only offer part of the solution. A more comprehensive, whole-systems perspective is needed. One such perspective may be found in the emerging field of industrial ecology.

Industrial ecology examines the co-evolution of technological and natural systems and looks at products and processes from cradle-to-grave. Within the fast-growing body of work on industrial ecology, studies have been done on the management of cleaner technologies and clean production, on collaborative decision-making between firms and their stakeholders and on changes within the organizational structure and cultures of firms. Research along these lines has advanced new metaphors, including: eco-efficiency, environmental comakership, sustainability strategy, life cycle analysis, integral chain management, extension of product durability, recyclability, and full-cost accounting.⁸² The International Human Dimensions Programme on Global Environmental Change (IHDP) has outlined an agenda for research on industrial ecology and transformation. The IHDP agenda underscores the promise expanding firm, plant and site-specific measures for pollution prevention across firms in industrial sectors to production chains and networks.⁸³

In the U.S., research on industrial ecology has begun to get support from the National Science Foundation (NSF), the Department of Energy (DOE), government laboratories, and university-based research centers.⁸⁴ During May 1995, the U.S.-EPA, the Research Triangle Institute, and the UC San Diego CONNECT program convened the first ever industrial ecology for border area economic development workshop. The objective of the workshop was to explore applications of IE and environmental technology to economic development in the U.S.-Mexico border area.⁸⁵ Special attention was

82. See generally T.E. GRAEDEL & B.R. ALLENBY, *INDUSTRIAL ECOLOGY* (1995).

83. The IHDP posted a major on-line document. See *Research Direction* (visited Feb. 23, 2000) <<http://www.vu.nl/english/oo/instituten/IVM/projects/research/ihdpit/hdprep/chap3.>>.

84. See IDDO K. WERNICK & JESSE H. AUSUBEL, *INDUSTRIAL ECOLOGY: SOME DIRECTIONS FOR RESEARCH*, a pre-publication draft (1997); see also *Office of Energy and Environmental Studies and the Lawrence Livermore National Laboratory* (visited May 29, 2000) <<http://www.Phe.rockefeller.edu/ieagenda/>>.

85. Cosponsors of the workshop included the California Environmental Technology Center, UCSD's Institute of the Americas, the National Association of Industrial and Office Properties, the President's Council on Sustainable Development, the Southwestern College Small Business Development and International Trade Center, the Urban Land Institute, the U.S.-Mexico Border Progress Foundation, and the IOA's U.S.-Mexico Environmental Business

was focused on promoting Eco-industrial Parks (EIP). Ernie Lowe, et al., define an EIP as “a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials.”⁸⁶ Components of this approach include new or retrofitted design of park infrastructure and plants; pollution prevention; energy efficiency; and inter-company partnering.⁸⁷ An EIP is being developed in the Brownsville-Matamoros Twin City, but there is nothing like it yet planned for San Diego or Tijuana.

To develop effective transborder EMS networks and industrial ecology depends on the mobilization of social, political, economic and technical resources. It also depends heavily on the creation, integration and sharing of knowledge. Hence regional universities and centers for research have a crucial role to play. The fact that UC San Diego is home base to the NSF-funded National Partnership for Advanced Computational Infrastructure (NPACI) is especially significant in this regard. NPACI provides an important platform for multidisciplinary research to develop and employ the next generation of communication networks, associated information repositories, collaborative technologies, and knowledge management techniques to gather, create, distribute, use, and evaluate knowledge in new and secure ways.⁸⁸ NPACI is headquartered at the San Diego Supercomputer Center (SDSC) on the UCSD campus.

With access to the Supercomputer Center, UCSD’s Urban Studies and Planning Program is in the process of building a City-Regions Workbench.⁸⁹ The City-Regions Workbench is a web-based “knowledge networking” tool for building a trusted, high-quality, research and action collaborative. The NSF defines knowledge networking as a process of “attaining new levels of knowledge integration, information flow, and interactivity among people, organizations and communities.”⁹⁰ Three broad objectives of the City-Regions Workbench are to: (1) Empower scientists and students with pri-

Committee.

86. ERNEST A. LOWE, JOHN L. WARREN & STEPHEN R. MORAN, *DISCOVERING INDUSTRIAL ECOLOGY: AN EXECUTIVE BRIEFING AND SOURCEBOOK* 142 (1997).

87. The prototypical and oft-cited exemplar for this application of industrial ecology is in Kalundborg, Denmark. The town of Kalundborg’s manufacturing base has evolved into an “industrial symbiosis.” Four large industries and part of the town’s utility infrastructure are tied together in a system of material and energy resources exchanges (where byproducts for one process become feedstocks for another). Analysts report that the environmental impact of industry in the area has decreased at the same time that the need for energy and raw materials has decreased. See John R. Ehrenfeld & Nicholas Gertler, *The Kalundborg Industrial Symbiosis—Industrial Ecology in Practice*, Working Paper, MIT (1996).

88. See *National Partnership for Advanced Computational Infrastructure* (visited May 29, 2000) <<http://www.npaci.edu>>.

89. See *UCSD City-Regions Workbench* (visited May 29, 2000) <<http://usp.ucsd.edu/~kpezzoli>>.

90. *Knowledge and Distributed Intelligence* (visited May 29, 2000) <<http://www.nsf.gov/kdi>>.

mary data, internet tools and links to facilitate research; (2) Develop a series of integrated “knowledge clusters” to facilitate multidisciplinary research (a “knowledge cluster” is defined here as coherent group of select topics with associated archives, professional and institutional contacts, data sources, data mining tools, metrics, methods and annotated guides for inquiry and action); and (3). Enable the linkage of researchers to the end-users of research in the San Diego-Tijuana global city-region and beyond.

The biggest challenge is to integrate information technology and communications issues with domain science and policy issues. This is a necessary step toward creating more efficient, interactive, and equitable methods for integrating university-based science with the fast-changing needs of industry, government, non-profit and community-based organizations. High quality, interactive informational systems can enable scientists, engineers, regulators, community organizations, and other members of society to act in concert to address ever more complex scientific and societal problems. Defining such systems is a crucial challenge for those looking to get the most out of EMSs. The City-Regions Workbench is being constructed with this challenge in mind. Success demands novel efforts to enrich academic discourse with civic knowledge, and vice versa.

The rising importance of informational forms of economic production and management for the generation of wealth is one of the defining features of the “new competitive landscape” at the dawn of the new millenium. More research needs to be done to better understand the far-reaching structural reforms associated with trade liberalization and the increasingly competitive pressure of a multi-polar world economy—especially where such pressure is encouraging firms to adopt an EMS and shift their environmental strategies from a reactive to proactive orientation. A guiding hypothesis for such research is that the pooling of technical and financial resources by industry, government, academia, and other interested partners is resulting in a *synergism* that can be favorable for industrial greening.⁹¹ Along these lines, the San Diego-Tijuana region is an especially promising testing ground.

91. See generally LANCE H. GUNDERSON, C.S. HOLLING & STEPHEN S. LIGHT (EDS.), *BARRIERS AND BRIDGES TO THE RENEWAL OF ECOSYSTEMS AND INSTITUTIONS* (1995).

