



Executive Summary

The State of the Border and the Health of its Citizens: Indicators of Progress, 1993-2023 Conclusions and Recommendations

The fifth meeting of the Southwest Center for Environmental Research and Policy's Border Institute series—co-sponsored by the U.S. Environmental Protection Agency (EPA) Office of International Affairs (OIA), the U.S.-Mexico Chamber of Commerce, and the Border Trade Alliance (BTA)—held annually in Rio Rico, Arizona, was dedicated to environmental quality and environmental health indicators. After three days of presentations, workshops, and discussions, participants offered several recommendations for future policy, which are summarized here. The process, background, and participation are outlined in the Executive Summary of the proceedings that follows this brief outline of general and media-specific recommendations.

GENERAL RECOMMENDATIONS

1. Baseline data are critical to any planning effort and the subsequent evaluation of a program's effectiveness. The Border XXI indicator suite was a valuable initial effort. However, it was largely U.S.-oriented and was intended mostly for program evaluation purposes and less for the communities it was intended to serve. It is recommended that, **as soon as possible, a binational baseline indicator suite be developed.** Then, Border 2012 will have a valuable assessment tool for program effectiveness. As well, communities will have a baseline to understand their own progress and/or failures and to compare themselves to other communities.

2. Indicators are most useful when they are localized to focus on a specific community. Because of the transboundary nature of pollution and its effects on the border region, often this means collecting data from both countries and using it to create a single indicator that reflects the impact the pollutant and the political border have on each distinct community. Designating unofficial, binational, common airbasins is an example of one indicator representative of the situation on both sides of the border. It is recommended that **indicators be scaled to assess the local sister-city communities that exist along the border.** This way, indicators inform both sides about conditions addressing their binational nature.

3. Data from the two sides of the border are usually different. Data are collected by different agencies, in different ways, at different scales, for different uses, and sometimes from different sources. The challenge for border researchers and practitioners is to harmonize data sets across the border to facilitate understanding of the region and of each side of the political boundary. It is recommended that **data be analyzed and supplemented to develop one common way to communicate to both sides of the border the status of an environmental issue that a particular indicator measures**. A common data set allows accurate assessment of the region. Adopting the standard of only one side does not fully capture the issue on the other side.

4. Health in the border region is exacerbated by aridity, poverty, crowding, and cultural issues. It is recommended that **border-specific epidemiological studies be conducted to establish the exact link between environmental quality and environmental health in these communities**. Programs can be tailored to address the most urgent and easily resolved health issues first.

5. The largest funding source for public U.S.-Mexican border infrastructure projects, the Border Environment Infrastructure Fund (BEIF), is expended through the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBank) certification and funding mechanism. Projects are implemented without conducting a baseline study specific to that place or follow-up assessment of the health of the community and its residents as it relates to the infrastructure project. This raises the possibility that some funded activities may have no proven environmental quality or environmental health benefit. It is recommended that **BECC conduct pre- and post-project environmental health assessments to determine the need for and impact of its infrastructure projects**. By doing so, over time, return on investment will be optimized.

6. Environmental efforts are often initiated without private sector involvement, except in compliance and monitoring, even though market forces have the power to affect substantial environmental changes. It is recommended that **indicator development significantly and continuously consider and integrate the needs and capabilities of the private sector to resolve problems**. By harnessing the power of the private sector, real and sustainable changes can be made.

7. The best manager of an indicators initiative is a disinterested, regional, data-proficient organization. Programs that have had experience with binational data acquisition, reconciliation, indicator development, and analysis can improve upon existing raw data. It is recommended that such **an organization be contracted as the indicator manager to collect, analyze, and disseminate indicators**.

AIR

8. While some air quality monitoring stations exist in the border region, the system inadequately covers regions along the border. It is recommended that **an adequate air quality monitoring system—properly sited, maintained, staffed, and reported—be**

installed in all fourteen major sister-cities. Then, real-time data will be available for alerting communities to particularly bad air quality days; and for planning, monitoring, and remediation efforts.

9. The air quality in the border region is aggravated by dirt roads, an aging fleet of vehicles (a subset of which are super-emitters), poor vehicle maintenance, and lack of vehicle smog inspections, among other factors. It is recommended that **a cost-benefit analysis be performed to compare and contrast various strategies for cleaning the air.** For example, some dirt streets are drier and thus are sources of much more vehicle-driven dust (up to 280 grams of dust per kilometer traveled). They are also proximate to larger pockets of the population than others. BECC and NADBank have been asked to fund paving projects. Such an analysis would show the best project to fund in each sister city area.

10. Indoor air is sometimes more unhealthy than ambient outdoor air. When people burn materials indoors to cook food or heat themselves, when they store pesticides and other agricultural chemicals indoors, or when they have unimproved dirt floors, indoor air can be especially bad. Cooking smoke is also associated with some tuberculosis cases. It is recommended that **indoor air quality be monitored and that the exact threat from indoor air in different communities be assessed.**

11. A number of air pollution-related health complaints are documented for border communities, but each has complications that elude common data sets. It is recommended that since **“pulmonary distress” has a common diagnosis and reporting system, it should be used as the binational environmental health indicator for air.** A common indicator allows comparison across borders and time, and among communities.

WATER

12. Water data are often proprietary, changing, complex, and scattered among various agencies. Information needed includes the transboundary nature of the water supply, the interactions between surface and groundwater, and the interdependency between supply and quality. It is recommended that **a binational water database be developed.** Such information is necessary for planning and managing the border's water resources.

13. The transboundary nature of water supply, the interactions between surface and groundwater, and the interdependency between supply and quality mandates that Border 2012 have strong water indicators. It is recommended that **water supply, tap water quality, wastewater treatment, surface water quality, and reclamation/reuse indicators be developed and used.** Such an assessment and the resulting warning system is a step toward sustaining border water.

14. A binational agreement is needed to facilitate water studies and information management. It is recommended that **the International Boundary and Water Commission (IBWC) and Comisión Internacional de Límites y Agua (CILA) draft a**

minute with the intent of coordinating and collaborating on general water studies and data management. The binational region would benefit from a single repository of water data.

15. Little is known about the groundwater in the border region, including its quality, amount, interactions with surface waters, or pathways of pathogens and contaminants. It is recommended that **binational cooperation, collaboration, and funding be focused on assessing binational groundwater assets.** Future water planning depends upon such data.

16. Water-borne diseases threaten the border region. Many people suffer from diarrhea and gastrointestinal distress and disorders, particularly infants, as seen in infant mortality rates. It is recommended that data about **pathogens, contaminants, symptoms, and diseases be collected and cross-referenced, and that remedial actions be prioritized.** This will enable a responsive disease prevention and care system to be developed.

17. Many water issues can be effectively addressed through education and training. It is recommended that **a Border 2012 task force be established to develop and provide water training.** This will enable border residents to address their own water-related health concerns.

PESTICIDES

18. Farm workers and their families that live proximate to farms are most at risk from pesticides. It is recommended that **amounts, use patterns, and area covered be used as indicators.** Exposure can thus be calculated.

19. Pesticides are usually pest-specific. To address all pests, as well as new exotic species, a binational integrated pest management (IPM) system is necessary, but the development of one is inhibited by the existence of the political border. It is recommended that **a list and assessment of weeds and pests be developed and shared across the border.** Then, the extraterritorial nature of pesticides, as well as invasive introduced species, can be addressed.

20. The use of land is changing as wild lands are transformed into farms, farms are transformed into homes, and some land is altogether abandoned. Often the intended use of land on the other side of the border is unknown, which means a neighborhood could spring up directly across the border from a farm using illegally imported or inappropriate amounts of pesticides. It is recommended that **a joint local land use plan be shared.** Land, water, and pesticide use along the border can better be managed binationally.

21. A common definition of pesticide poisoning is needed. It is recommended that **medical training be provided to detect, treat, and report acute pesticide poisoning.** The common standardized database will allow priorities for action to be set.

22. Adequate regulations to regulate pesticide use already exist. It is recommended that **existing pesticide regulations be enforced at all levels, from commercial agriculture through the home garden.** This protects not only the agricultural worker but the home gardener, whom a growing number of studies show can be affected by readily available pesticides.

23. Pesticides are used intensively in some agricultural areas of the border region. It is recommended that **proximity to population centers and drift (transport from site of application) be measured to determine actual potential risk from pesticides.** Then the local and transboundary nature of the threat can be determined.

24. A standard test is needed to detect pesticide poisoning in farm workers. It is recommended that **cholinesterase blood tests be used by researchers and health practitioners to detect pesticide exposure in those who regularly work with pesticides.** This way a common measure can be used and reported on both sides of the border.

INTRODUCTION

Mexico's Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) has worthy a vision of the U.S.-Mexican border region: dynamic, competitive, ordered, integrated socially and economically, environmentally sound, and a model of equitable sustainable development.

Unfortunately, the border region is nowhere near this vision. In 2001, the Southwest Center for Environmental Research and Policy (SCERP) painted a bleak picture of the region in the conclusions and recommendations from its Border Institute III annual policy seminar:

A notable lack of infrastructure has produced deterioration of surface and underground water quality due to untreated waste water or renegade sewage flows. Every border community faces an impending crisis in providing water for urban, industrial, and agricultural purposes. Natural resources, endangered species, and important ecosystems are threatened by rapid urbanization and industrialization. Many border communities cannot meet U.S. or Mexican air quality standards, and corresponding human health impacts are on the rise. (SCERP 2003)

It should come as no surprise that the environment in the U.S.-Mexican border region is facing severe challenges to its sustainable survival and that the health of its citizens is suffering because of it. SCERP and others have studied the region for years and the message is rarely any more encouraging. The border is being sold out—and at a bargain price. Border residents pay the price of water, not the cost of water; they pay the price of a potato, not the agricultural and environmental costs of growing it; they pay the higher price of goods produced by industries that mitigate a small amount of air pollution, not the cost to clean the air; they pay the price of health care, not the cost of prevention.

The border region's population is growing at an unprecedented rate. According to Peach and Williams (2000), in 1995 the border region population was 10.6 million, and if current migration trends are sustained, that number could grow to as many as 24.1 million by 2020. Poverty is extreme, as evidenced by unemployment rates that are generally higher in border cities when compared to the national average, and the fact that the employment that is available tends to be in low-wage jobs (Peach and Williams 2000). In 1995, U.S. border counties had per capita income levels of 79.2% of the national average, but removing the relatively wealthy San Diego County from that list brings the percentage to 61.9 (Peach and Williams 2000). Although the Mexican border region is prosperous compared to the rest of the country (SCERP 2003), gross domestic product (GDP) rates there are still significantly lower than the GDP rates of U.S. border counties.

In the face of all these problems, Border Institute V, the fifth annual policy seminar co-sponsored by SCERP, the U.S. Environmental Protection Agency (EPA) Office of International Affairs, SEMARNAT, the Border Trade Alliance, and the U.S.-Mexico Chamber of Commerce, convened April 28–30, 2003, in Rio Rico, Arizona, to discuss

the use of environmental health indicators to highlight extreme conditions, to determine baseline conditions, and as a reason to push for progress on many of these environmental issues. SCERP's Border Institute series, which began in 1998, enables the leading local, state, national, and international planners and decision makers to meet, become informed about issues and options, and discuss the best alternatives for the environmental future of the U.S.-Mexican border region. At Border Institute V, 90 of these senior-level researchers and officials participated in three days of discussions in which they identified, analyzed, and prioritized issues related to environmental health indicators. Finally, they proposed a variety of indicators and made policy recommendations to guide agencies that operate in the border region on how to proceed using the knowledge gained at Border Institute V.

A Brief History of the SCERP Indicator Project

As authors Colin Griswold and Glen Sparrow describe in their report:

indicator[s] ... are used to observe, over time, some measurable portion of a major phenomenon so that changes in its condition can be recorded and determinations made as to whether the changes are trending in a positive or negative manner.

This information is then used to influence public opinion and create pressure on decision makers to continue or adjust policy concerning the major phenomenon the indicators measure, the authors continued. The value of indicators is that they collect and disseminate reliable and accurate information, which helps the public and policy makers develop a correct understanding of a situation so that they can use public resources wisely.

How to properly guide the use of public resources for the public benefit was a challenge presented to participants at Border Institute V. Over the years, the variety of U.S.-Mexican border agencies have spent profuse amounts of money and resources trying to solve environmental problems. But, their impact is unknown because there is no way to track success. Without a method for tracking success, quantifying environmental change is difficult, as is evaluating whether these programs are making progress toward the ultimate goal—improving the health of border residents. As well, it is difficult, if not impossible, to determine whether the efforts are achieving the goal of sustainability—defined as continuously creating chances to evolve and opportunities to renew without exhausting natural resources or polluting common resources. In turn, there is no way to tell whether working toward sustainability is having a positive effect on environmental quality and environmental health.

Border agencies soon realized that a suite of environmental health indicators would serve as that tracking system for the U.S.-Mexican border region, and developing those indicators became one goal of the Border 2012 program, which is a joint initiative of EPA, SEMARNAT, the U.S. Department of Health and Human Services, and Mexico's Secretaría de Salud. EPA and SEMARNAT turned to SCERP in 2002 for assistance in reaching that goal; SCERP accepted the challenge and began developing an environmental indicators suite for the region.

The team of researchers and stakeholders learned quickly that this would be no easy task. The biggest obstacle in an indicator project, the team learned, is gathering reliable

and accurate data. There are other obstacles, too. When studying two distinct countries like the United States and Mexico, comparable information is not usually available, data can be outdated and/or dispersed among a variety of agencies, monitoring systems that collect data are not always reliable, and those who collect the data often are not properly trained.

With this experience, SCERP determined that for indicators to be effective they must be **TRUE**: **T**imely, **T**argeted, and **T**hreshold-sensitive; **R**eliable, **R**elevant, and **R**esponsive; **U**seful to the public, policy-makers, and program administrators; and **E**asily accessible from both sides of the border, from reputable sources, on a periodic basis. In developing the draft Index of Indicators for the Border 2012 Program, SCERP also found that it is imperative to create an open, transparent process that affords professionals and stakeholders from both nations an active voice and forum. Academia eventually turns over these indicators to this community of stakeholders, and if that community's unique voice is not heard in the final product they won't use the indicators, because they will view the indicators as forced upon the community by outside researchers who didn't listen to their concerns.

The Border 2012 Draft Index of Indicators

The result of this process and these lessons learned is the Border 2012 Index of Indicators, the primary purpose of which is to serve as a reference point for communities. The Index of Indicators will enable communities to compare environmental quality and health conditions in their areas with conditions in other communities, and measure improvement from baseline conditions in their region. The indicators can also be used to compare conditions over time. Beyond the scope of a local community, the Border 2012 indicators enable stakeholders throughout the U.S.-Mexican border region—including governments, industries, non-governmental organizations, advocacy organizations, and academia—to measure progress over time toward reaching the goal of a clean and sustainable future with high environmental quality and good environmental health.

The Border 2012 Index of Indicators includes data from more than just the four agencies that developed the Border 2012 Program. The index integrates the efforts of four other types of organizations dealing with the U.S.-Mexican border environment:

First, some indicators address activities and measurements from entities that were established by U.S.-Mexican treaty, such as the U.S.-based International Boundary and Water Commission (IBWC) and its Mexican counterpart, Comisión Internacional de Límites y Agua (CILA). Second, the index incorporates information from existing organizations whose scope is border-wide, such as the Good Neighbor Environmental Board (GNEB), the Border Trade Alliance (BTA), and the U.S.-Mexico Chamber of Commerce. Third, data from and the activities of binational and trinational commissions created by NAFTA, such as the Commission for Environmental Cooperation (CEC), Border Environment Cooperation Commission (BECC), and the North American Development Bank (NADBank), are integrated. Finally, information and activities of agencies created after NAFTA's implementation are included, such as the Border Health Commission (BHC) in the United States, the Comisión de Asuntos de la Frontera Norte, or Mexico's Northern Border Affairs Commission, and others. The Border 2012 Index of Indicators also includes data from the outcomes of projects funded by the

largest funding stream available to and for the border region—the Border Environment Infrastructure Fund (BEIF). The BEIF aims to make environmental infrastructure projects affordable for communities throughout the U.S.-Mexico border region by combining grant funds with loans or guaranties for projects that would otherwise be financially unfeasible, according to NADBank, which administers the fund. Communities that receive BEIF funding must be prepared to transition their projects from highly subsidized to self-sustaining.

With the Index of Indicators in hand, Border Institute V participants began the policy seminar with a discussion of the status of the border region in a state-by-state analysis, and continued in outlining the role of environmental indicators and their relationship to environmental health. The seminar culminated with the development of additional indicators and policy recommendations border agencies can use to take action on air, water, and pesticide concerns.

STATE OF THE BORDER ENVIRONMENT REPORT

In preparation for Border Institute V, teams of researchers in the geographic regions of California-Baja California; Arizona-Sonora; New Mexico-Chihuahua; the Paso del Norte region of Texas; and Coahuila, Nuevo León, Tamaulipas, and Ciudad Juárez evaluated the current conditions of their environments. A team also studied the border region's tribal nations. Overall, the picture was not encouraging, further displaying the need for a system of indicators to track environmental conditions.

California-Baja California

The California-Baja California border region comprises two Southern California counties and four Baja California municipalities. Its topography, geography, and climate are varied, encompassing coastal zones, mesas, mountains, valleys, and deserts. It has moderate temperatures along the coast and more extreme temperatures in the inland valleys, mountains, and deserts. This unique environmental setting supports a rich diversity of plants and animals, many of which are threatened or endangered.

Since World War II, the region's population has skyrocketed, fueled primarily by migration. All counties and municipalities in the California-Baja California border region currently have problems providing adequate levels of environmental infrastructure and services.

For example, the region's water supply is imported, particularly from the Colorado River. Locally, some measure of aquifers and surface water are available, but not in the quantities necessary to support the regional population. Ultimately, using the Colorado River as a source will prove insufficient as the region continues to grow; as a result, other sources are now being pursued, including reclaimed water and seawater desalination. Water quality issues are also a concern in the region. The rapidly growing population on the Mexican side of the border has overwhelmed sewage infrastructure, while pollution and salinity concerns plague U.S. communities.

Another consequence of the rapid population growth in the region is the concern over solid and hazardous waste. Communities on both sides of the border lack adequate landfill space for the future, recycling programs still encounter obstacles, and improper disposal of trash due to the lack of public education and municipal collection services is a concern. Hazardous waste, meanwhile, is a serious problem, especially on the

Mexican side of the border. Although many maquiladoras produce less hazardous waste than generally thought, many domestic businesses fail to properly dispose of hazardous waste.

In addition to these factors:

- Air quality and energy issues are increasing in importance, as increasing energy demand will continue to put pressure on air quality
- Rapid urbanization and land use changes in the border region have affected the diverse natural communities and species of the region
- Credible estimates are that 25% to 33% of human disease can be attributed to environmental risk factors, but more research and analysis are needed to clearly describe the links between environmental factors and human health

At present, several environmental problems in the California-Baja California border region require binational solutions, but the lack of uniform transborder data hinders their resolution. However, the amount of available data is steadily increasing, giving policymakers more tools to support their decision-making. New administrative mechanisms have emerged to address many challenges related to border environmental quality, and progress has been made in some areas, including expanded wastewater collection and treatment services.

Arizona-Sonora

The Arizona-Sonora border region is commonly identified as the four counties in Arizona and 11 *municipios* in Sonora adjacent to the international boundary. Hot and dry climate, scarce water resources, and varied desert topography characterize the area.

The region's population growth, expected to exceed 2.1 million by 2010, has placed tremendous pressure on available resources and infrastructure. Like elsewhere in the U.S.-Mexican border, Sonora's border cities are several times larger in population than their counterparts on the Arizona side. Largely attributable to migration from the interior of Mexico in search of jobs, this disparity creates severe implications for Arizona border cities, which struggle to absorb the impacts of increasing trade, traffic, and migration without adequate financial resources. Local and regional governments on both sides of the border struggle to meet growing demands for water, sewage, health care, roads, housing, and other services.

Agriculture, mining, and increasing international trade shape the use of the land in ways that impact vegetative communities, soil structure, and faunal and habitat ranges. Human activity, most notably in the past century, has dramatically altered the landscape of the Arizona-Sonora border, affecting both the quality and quantity of its ecological resources. But one of the most pressing issues for the Arizona-Sonora border is the impact of illegal human and vehicular traffic through unique and environmentally sensitive areas. Many of these locations now bear the scars of wildcat trails, abandoned refuse, and trampled vegetation.

Communities face a host of other issues. Water is arguably the most debated and coveted resource in the arid desert region of Arizona and Sonora as population growth and climatic changes influence competition among users for this increasingly fixed supply. Appropriate management (transportation, tracking, and disposal/storage) of

hazardous waste is difficult, given the maze of conflicting jurisdictional requirements and incompatible tracking systems in place at the border. As well, unpaved roads, idling trucks, brick kilns, mining, exposed agricultural lands, landfills, and residential activities such as heating homes and cooking food all impact air quality.

While state and federal agencies, and non-governmental organizations (NGOs) in the Arizona-Sonora border region are engaged in an extensive body of work, a holistic approach to eco-resource management and the development of compatible data is imperative to rehabilitate and preserve the rich diversity of biological features that exist along the U.S.-Mexican border. The lack of available data is a major challenge in assessing environmental issues.

New Mexico-Chihuahua

This region is situated at the northern end of the vast Chihuahua Desert. Characterized by rabbit brush, mesquite, and creosote, this is a desert where mankind has yet to lay full claim to the land. On a hot summer day, only the native rabbits and a few cattle can be seen. At night, burrowing owls, rattlesnakes, and coyote roam freely.

Along the New Mexico-Chihuahua border, water ranks as the most important limiting resource. Its significance is uncontested. More than 90% of regional communities on both sides of the border receive their water from underground aquifers. Quality of water also ranks as an important environmental issue. In southern New Mexico, some 40% of wells have been found to be contaminated by a variety of sources, including septic waste, agricultural production, and industrial sources. A current worry among border communities is how to prepare their citizens for water conservation and other measures under drought conditions. Now in its third documented year, the region suffers from mild to severe drought.

The region is fortunate to possess enough capacity to handle both its hazardous and solid waste volumes. A more pressing concern is the lack of citizen compliance with existing solid waste disposal rules and a failure to enforce regulations for proper disposal at existing facilities. Some burning of trash and other materials in rural areas also creates problems with air quality, which has long been a difficult issue to address along New Mexico's border with Mexico.

Outsiders are often unprepared for the extreme poverty that exists in both Mexico and the United States in this section of the border. The U.S. Census Bureau reports 25% of U.S. residents live below the federal poverty level, while on the New Mexican side of the border, per capita income averages merely 64% of the U.S. national average. In many respects, there is no bottom to poverty in this region.

Many residents on both sides of the border are not familiar with the connection between health and the environment. As a result, preventable illnesses occur due to personal behaviors that result in contamination of the environment or exposure to environmental agents.

Paso del Norte

Texas' border region encompasses all or part of 32 counties. Urban populations are growing rapidly in the border region, exceeding growth throughout the rest of the state and much of the nation. With this boom has come both an increased demand for water supplies and a strain on communities' water, wastewater, and waste management

infrastructure. Per capita income is lower in the border region than other parts of Texas as a whole.

Between 1996 and 2000, total U.S. exports and imports with Mexico (as measured in dollars) almost doubled. The region's economy depends on agriculture, ranching, oil and gas production, trade and commerce, industry, and tourism. While foreign-owned maquiladoras have thrived and attracted more residents to the border for employment, the influx of people increases the demand for drinking water, wastewater treatment, solid waste landfills, collection stations, garbage pickup, and recycling.

Illegal dumping is the top border waste management problem. Border residents are requesting assurance that hazardous materials will be transported, stored, and disposed of safely. Hazardous waste management, while a concern, is a more severe problem in other parts of the state than along the border because there is less major industry along the border than in other parts of Texas.

The pressure on the quantity and quality of the border water supply is the chief concern expressed by border residents. Many communities along the border depend heavily on groundwater, but increased use is rapidly depleting the available amount of high-quality groundwater. As well, drought conditions have afflicted the border region since the early 1990s. One of the greatest threats to water quality is lack of sufficient water and wastewater infrastructure to keep pace with border growth.

Small communities, including *colonias* (unincorporated and usually underserved neighborhoods without adequate water, sewer, or transportation infrastructure), experience unique problems in developing and operating sufficient environmental infrastructure. Their need for technical assistance is much greater than current service provides. Border growth also impedes communities' abilities to manage the disposal of solid and hazardous wastes. Given the concentration of population around major metropolitan areas and the lack of waste services to *colonias* (particularly to those in rural areas), municipal solid waste issues are a principal concern.

Air quality problems along the border are localized. The major problems are in El Paso, which violates national standards for particulate matter, ozone, and carbon monoxide, and Big Bend National Park; however, the Texas Commission on Environmental Quality (TCEQ) continues to monitor pollution in Laredo and the Lower Rio Grande Valley.

Coahuila, Nuevo León, Tamaulipas, and Ciudad Juárez

The Río Bravo, as it is called in Mexico, runs for more than 1,200 miles, and part of it delineates the border between Mexico and Texas. Seven sister cities have grown up along this thin slice of green land within the Chihuahuan Desert. The climate in the Rio Grande river basin ranges from arid to semi-arid. The population in the seven sister cities has doubled every 20 years and is expected to reach 8 million in 2030.

The North American Free Trade Agreement (NAFTA) has no doubt fueled economic growth on the border between Mexico and the United States. For the period between 1970 and 1997, the region has expanded beyond the U.S. growth rate in the economic sectors of manufacturing, transport, wholesale and retail trade, real estate, finance, and services. Expansion of maquiladoras has been rapid over the past two decades, which has led to the increase in employment, value-added, and import inputs on both sides of the border (Hanson 2001).

Degradation of air quality along the border has been an issue for more than a decade. Three cities on or near the Texas-Mexico border (Anthony, N.M., Sunland Park, N.M., and El Paso, Tex.) reported exceedances of the U.S. National Ambient Air Quality Standards for particulate matter, ozone, and carbon monoxide (EPA 2000a). On the Mexican side, Ciudad Juárez had exceedances for the same contaminants (EPA 2000b). The air quality of specific cities is important in that degradation trends tie in with NAFTA—exhaust fumes, much of which comes from vehicles waiting to cross the border, contribute increased levels of nitrogen oxides, carbon monoxide, and elevated levels of lead (Mukerjee 2001).

The Rio Grande airshed in Texas is greatly affected by the arid climate and wind erosion, which tend to elevate levels of particulate matter. A contributing factor is the lack of paved streets, especially on the Mexican side of the border. Other origins of particulate matter are dumping, burning, and barren croplands, which contribute to the degradation of the airshed (EPA 1998).

The major source of subsurface water in the upper part of the Rio Grande basin is the Hueco Bolson. Because of accelerated withdrawals in the past few decades, the bolson is projected to run dry by 2025. However, a \$50 million desalinization plant is in the process of being constructed to treat the brackish water contained in a secondary aquifer, the Mesilla Bolson (Schmandt 2002). On the Mexican side of the border, there are no resources to build a large-scale water treatment facility.

Water in the Lower Rio Grande Basin is mainly supplied from the Mexican side of the border. Because the subsurface aquifers have low-quality water that cannot be used even for agriculture, a two-reservoir, jointly owned U.S.-Mexican system was established in the 1950s and 1960s. However, these levels are still not adequate for both agriculture and municipal needs for the present year (Drought Preparedness Council 2003). The hope is that through organizations like the international, non-governmental Paso del Norte Water Task Force, there will be enough water for future needs (Schmandt 2002).

Tribal Nations

The indigenous cultural heritage of Mexico's border region includes native tribes and migrant indigenous groups. Just as the definition of the U.S.-Mexican border region as the 100 kilometers (km) extending on either side of the international boundary is problematic when considering ecosystems, watersheds, and other natural configurations, it likewise leads to arbitrary distinctions when discussing tribal nations of the border region. For example, the territory of some groups extends beyond the 100km zone; other groups live outside the 100km range but are closely tied culturally, socially, politically, and economically to indigenous and non-indigenous populations within the range; still others are comprised of closely-related groups on both sides of the border whose entire territories are north and south of the 100km designation.

For migrant indigenous groups the concept of the border region is even more problematic because time in their residences may vary anywhere from a few hours or days in one place to permanent settlements in urban areas. Furthering the confusion, the U.S. and Mexican governments recognize only a few tribal peoples and many ethnicities and communities slip through the perceptions and the realities of the "saltcedar curtain."

Environmental issues affecting border tribal peoples include problems with air, water quantity and quality, toxic wastes, population, health, and economic opportunity. Tribal peoples inhabit a landscape that has been impoverished by overgrazing; depletion and contamination of water resources; mineral extraction and energy production; and social problems arising from the narcotics trade, the militarization of the border, and governmental neglect. They share these problems with all inhabitants of the border, but tribes are chronically under-represented, underemployed, and underserved by governmental programs. The true state of the indigenous endemic population and migration is unknown. Prioritization of environmental problems and problem-solving strategies are often envisioned differently than the dominant culture since native world-views differ radically from those of the dominant culture.

The biggest problem, however, is the lack of data and inclusion of tribal nations in the process of discovery and sustainability. The gaps in knowledge are fundamental, ranging from the basic issue of inadequate demographic characterizations to a different world view and styles of communication and problem-solving. However, continued involvement with tribal nations has provided a sense of what the future research agenda should entail and how it should be conducted.

THE ROLE OF ENVIRONMENTAL INDICATORS

From general conditions to specific situations, indicators are used to measure progress. A vision can give an effort the direction it needs to move forward, but without indicators no one knows if positive movement is being made along that path, which is important to know because programs and policy respond optimally when their effectiveness is measured.

Specifically, indicators are increasingly used to accomplish one or more of the following:

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| • Envision a future | • Measure progress toward that vision |
| • Build knowledge-action collaborations | • Harmonize data |
| • Perceive threats, vulnerabilities, and risks | • Identify critical issues |
| • Clarify responsibilities | • Prioritize actions |
| • Evaluate policy and programs | • Motivate action or funding |
| • Catalyze awareness | • Monitor program effectiveness |
| • Explore relationships (i.e., identify “drivers”) | • Integrate socio-economic trends |
| • Design programs, designate goals, and develop objectives | |

Indicators are primarily intended for communities to use so they can assess and track their own status and progress relative to the past and relative to other communities. Also, with increasing pressure to perform, governments are using indicators to evaluate efficacy and cost-effectiveness of their programs. This is not always easy. Mere outputs are insufficient when outcomes are needed. Border 2012 has an indicators program for some of the above reasons. Griswold and Sparrow have written an entire chapter in this monograph about the challenges of designing and implementing an indicators program that has too many masters and expectations, and too great a demand for data.

Recently indicators have been used to link environmental quality and environmental health. While the exact causal relationship between exposure and health effects

remains elusive, indicators can unify the environmental and health communities in the common efforts to preserve and clean the environment to protect human health.

The Link Between Environment and Health

The lack of a system to track the success of efforts aimed at improving environmental quality, coupled with the problems delineated in the state of the border reports, suggests that a transparent system of environmental indicators is needed not only to measure improvements or deteriorations, but to prioritize environmental investments better, thus improving the health of border residents. However, a problem that arises is that the link between environmental quality and health is a tenuous one.

While intuition suggests that a polluted environment will cause ill health effects, no epidemiological studies show this outright connection. Environmental quality studies show *exposure* while environmental health studies begin with a *health effect*. It is that gap between exposure and health effect that is problematic. In the gap, are the issues of multiple source routes to humans, pathways into the body, dose levels and exposure times, recipient vulnerabilities, and somatic defenses and synergisms.

Linking to Governments and the Private Sector

Indicators need support from government and support from the private sector, but neither is easily obtained. Border issues—and thus border environmental indicators—are not viewed with the same level of importance by federal and state government officials as those who live and work on the border. This is evidenced by the fact that, as Border Institute participants learned, the Mexican federal government will not inject more money to border environmental programs, but will work toward helping existing programs become more efficient. As well, government agencies are not interested in carrying out indicator development projects, as Mexican and U.S. federal government representatives informed Border Institute V participants. These two points are hurdles to getting governments involved early on in environmental indicator initiatives, which is a must, or officials will not feel as though they have a stake in the initiative. And without that stake, governments will be reluctant to fund the development of indicators or programs that might arise out of the information gleaned by them.

Although indicator projects should be funded and carried out through the cooperation of governments and border agencies, the private sector plays a critical role. While more businesses in the border help bring economic stability—and ultimately, it is hoped, sustainability—to the region, their operations can be the sources of problems such as additional environmental pollution, limited housing supplies, and poor worker health. However, businesses are not the enemy. Their operations being located in the region means they have a stake in the border, an interest in healthy workers, and concern for the environment surrounding their operations. For the private sector to take interest in indicators, the sector's involvement must be solicited in the right way and in a timely manner. Border Institute participants heard from a variety of colleagues about the failure of Mexico's tax on maquiladoras because instead of being asked for good-neighborly financial help, law makers immediately turned to legislation. In general, businesses want to help the communities in which they operate, but they want their funds and efforts stay in those communities, and they want to see the everyday outcomes supported by their investments.

Implementing and Developing Indicator Projects

Visibility is the most important priority. Indicators must be presented to officials that might use them to make policy decisions. Border Institute participants determined that the task of prioritizing indicators can be left these policy makers, as each locality and region will have different levels of urgency and interest for each indicator. From there, the issue of indicator project funding—without appropriate levels of which indicators will go nowhere—will be addressed locally and regionally.

Once these varied elements fall into place, there are things to know about getting an indicator initiative off the ground, and a variety of tools that might be useful for gathering information to develop indicators and for exploring consequences when developing policy. When it comes to the nuts-and-bolts of implementation, EPA's Rebecca Calderon offered several suggestions:

- Start simply
- Start at a specific point in time by developing a baseline so there will be something against which to measure progress
- Build upon what is already available
- Think about the context of what is available
- Be realistic about the ability to measure a proposed indicator
- Educate the public throughout the process

Using Technology

Geospatial technologies—including remote sensing, digital elevation models (DEMs), global positioning systems (GPS), geographic information systems (GIS) and cartographic visualization—are tools that can be used to gather information for designated indicators. Geospatial technologies use a variety of imaging techniques for a variety of purposes. For example, geospatial technologies could be used to photograph an area and count the number of dwellings in it. That information could then be used to estimate a population in a particular area (based on already-gathered population figures from another source) and then to calculate that population's impact on the habitat.

Modeling software also provides opportunities in environmental indicator work. Decision support systems allow users to map out a flow of events, then enter hypothetical variables that change the elements or outcome of that flow of events. While users create a map and enter basic information and equations, the software builds more complex equations it uses to determine the impact of the variables on the flow of events. With this software, users can explore a modeling approach to figure out the unintended consequences of policy changes.

FINDINGS

Border Institute V participants spent the better part of three days learning about all these issues in detail, and the seminar culminated in participants pulling on their new-found knowledge and their own individual areas of expertise in three break-out discussions dealing with specific topics. The result was a host of general findings about undertaking indicator initiatives, as well as specific policy recommendations on air, water quality and quantity, and pesticides.

Overall Findings

Indicators projects should include the opinions of the public, health and environmental professionals and experts, the private sector, and representatives of state and national governments. These groups' unique viewpoints must have a voice in and impact on the development of indicators for their communities—the ultimate users of indicators. Stakeholders are much more likely to use a tool they've had a hand in developing.

Indicators need to be localized for a small-scale community; only from there can indicators be regionalized. Each region has different priorities, perceptions, and problems, and each region and locality knows—or should know—what it needs in terms of air quality, water quality and quantity, natural resources, and in other environmental arenas.

Data need to be harmonized across the border and among the regions along the border. For this to be successful, an evaluation must be made of the existing level of compatible data between border sister cities so that the baseline situation and subsequent needs are clearly delineated at the beginning of the endeavor. Akin to this is the need for accurate, reliable data upon which indicators can be developed. Accurate, reliable data about the border region are imperative for policy makers and lawmakers to do their jobs effectively. Context with regard to comparative risk must also be included.

The set of baseline indicators must be developed and agreed upon so that the current state of the environment can be accurately assessed. This should not be hard to achieve, since several border-related agencies—including the Pan American Health Organization (PAHO), GNEB, ADEQ, CEC, and BECC—have developed or are developing a variety of environmentally focused indicators. Given this, SCERP's role should be to relate indicators media-to-media and region-to-region, and relate environmental quality to environmental health. SCERP should also be the agency responsible for measuring, tracking, and relating indicators, but not to the detriment of efforts by existing indicator initiatives to work together and build capacity. Participants agreed that groups with indicator projects already underway should come together to share information, data, and experiences.

Specific Findings

Air

The group focusing on air quality recommended a multi-tier policy for using one indicator of air quality to incite change at many levels. Because outdoor and ambient air quality lead to upper respiratory distress, pulmonary distress should be the indicator for environmental air quality, the group decided.

There is a long-standing air monitoring system in place in three sister cities, El Paso-Ciudad Juárez, Calexico- Mexicali, and San Diego-Tijuana, but they are in need of major investment for things such as training of those who monitor the sites, quality assurance of data, equipment repair, and site relocation to a place of importance rather than convenience. In the first phase of the air group's proposed strategic plan, this air quality monitoring system would be expanded to the Yuma-San Luis Río Colorado sister city region, and the sister cities of Nogales-Nogales and Brownsville-Matamoros. As well, once funding becomes available, monitoring of air toxics—a growing concern in many communities—should be established in all sister cities. This first phase would also

include an outreach effort aimed at reducing respiratory distress from tobacco smoke and heating and cooking systems. Currently, the United States does not have statutory authority over indoor air quality and thus cannot deal with this problem legislatively. Ensuing outreach must ensure schools, libraries, community centers, and other public places have satisfactory indoor air systems; include education to let the public know they can have an impact by using different fuels for cooking and heating; and institute smoking cessation programs.

The next step—assuming quality, reliable data is available—is a pilot project to record pulmonary health information that can be provided to doctors via, perhaps, a provided computer system. Many partners should be involved, including SEMARNAT, SCERP, CEC, environmental professionals, health professionals, and the public. If that program is successful, the next step would provide air-health “correlations” in the seven biggest border cities, starting with the three sister cities that already have monitoring systems and expanding to the four that do not. The system would relate the instances of upper pulmonary distress against instances of air quality problems, while keeping in mind that a system like this does not tell the whole story of other factors, including pollen, for example.

The value of this overall approach is that it fosters the ability for data to mature over time—a situation whereby in the early years of the project data is first collected from relevant areas of a city, then in later years it progresses to being accurately collected by well-trained researchers, then further along data is analyzed and distributed in a timely way, and finally, the process results in attainment.

The group also recommended that:

- Air quality indexes already being used in a number of cities be expanded, because they contribute to public awareness about the problem and convey the problem to public officials
- Binational airsheds should be designated, an action that will lead to the development of binational plans
- Environmental health relationships be built between air quality professionals and health professionals
- An inclusive community-based partnership be developed
- Air quality officials and communities be brought into the process, because public awareness leads to public support, and that, it is hoped, would lead to appropriate funding for these projects

Water Quality and Quantity

Several problems plague the water arena: the United States has primary and secondary contaminants, yet Mexico has only primary contaminants; the health sector does not have the time or money to track water-borne diseases; there are no good links between water quality problems due to natural and human causes and water-borne illnesses; little communication exists between the health services and water testing authorities; follow-up after treatments are few and far between; lack of (cultural) trust negatively impacts efficient data exchange; most data is non-comparable; and there are no state and local agreements or binational data-collection programs. But, the group addressing water issues determined that the most important need was an assessment of what data are currently available. With that knowledge, policy makers could then work toward

evaluating the indicators and determine how to interact with environmental and public health officials.

The group's solution to this problem was to create, for lack of a better term, a "Data Dump." The Data Dump would be a mechanism—perhaps a website with a searchable database or web-based access to freely distributed software—at SCERP that would allow researchers to share existing information in whatever format in which it is currently available. Once the Data Dump is operational and sufficient funding is available, criteria for the form in which data should arrive and a protocol for sampling should be developed. Targets for sampling should be narrowed so that sampling is conducted on only those contaminants that are of immediate concern for health (which means those contaminants will have to be identified). An assessment should then be made of the most important symptoms that arise out of health data.

In the long term, those who run and use the Data Dump can identify obstacles and develop a plan for institutional reform or some sort of binational agreement that could streamline the process of data exchange. Eventually, these binational indicators should be used to create an alternate network through which water quality monitors alert health professionals to problems with the system that may manifest in poor health, and vice-versa, a system in which health professionals would alert water quality professionals to symptoms in the population so the water quality professionals can assess the water supplies.

This effort need not be taken to the highest levels of formality or to state and national governments, as there are many instances of successful local cooperation from which indicator developers can learn. As well, this collaboration would take advantage of local groups' institutional knowledge about the specific regions or problems they study.

Under the proposed matrix, the federal governments would provide funds and regulatory actions; states would provide funding; local entities would provide surveillance, agreements, training, and work; NGOs would develop cooperative agreements and educational programs; and academia would provide education and lab training.

The water also highlighted the needs for:

- A BECC requirement that communities conduct follow-up studies on the effect of treatments on health
- Annual, at least, reports by epidemiologists and government water authorities in one database
- Research on pathways between groundwater and surface water
- Research on how pathogens move through geologic structures
- An open IBWC-CILA minute to do general studies so each study does not require separate negotiations
- Incentives for collaboration
- Institutional reform to streamline processes and eliminate barriers
- A change in the culture of data propriety
- Elimination of duplicate efforts
- A streamlined validation process
- Identification of data to be processed and distributed quickly
- A protocol for binational groundwater monitoring, which could facilitate funding for the creation of sampling and analysis

- Identification of priority contaminants and priority symptoms
- Creation of task forces for training

Pesticides

There are a number of problems associated with pesticides and other chemicals used to kill animals or substances, including drift, exposure, professional capabilities, and indoor exposure. The group that addressed these concerns identified several possible indicators and resulting policy recommendations.

To address drift, some sort of proximity measure must be developed, perhaps by assessing the mechanism of application to determine how much drift occurs. Then, agriculture and urban-area officials can come together to make a joint determination that improper land use will make residential areas or commercial areas more vulnerable to drift.

Possible indicators for exposure include medical testing or sample testing (via a cholinesterase blood test) for exposure; the number or percentage of farms using integrated pest management; and the quality and type of pesticide being used and the amount of surface area covered with them. Once that information is available, decision makers can work toward reduction and elimination of the most toxic pesticides and herbicides. As well, the private sector can contribute research in this area and then provide education for farm workers about the types of contaminants and toxics they use day-to-day.

An indicator of professional capabilities should determine the number of medical professionals trained in pesticide-related illnesses. Then, decision makers should provide curriculum updates, ensuring that there are workshops and certificate programs for these medical professionals.

A study recently conducted on indoor pesticides should be reviewed for appropriate indicators. Then, decision makers should promote health-based policy to reduce and control home products, as there are some products that have been banned for agricultural use but are still used in home gardens.

Overall, the group determined that more education is needed in the area of pesticides, both for health professionals and for those handling the material in commercial fields and home gardens, to make the connection between environment and health. In addition to this, existing regulations—which are many and adequate—need to be enforced at all levels, from commercial agriculture through to the home garden.

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