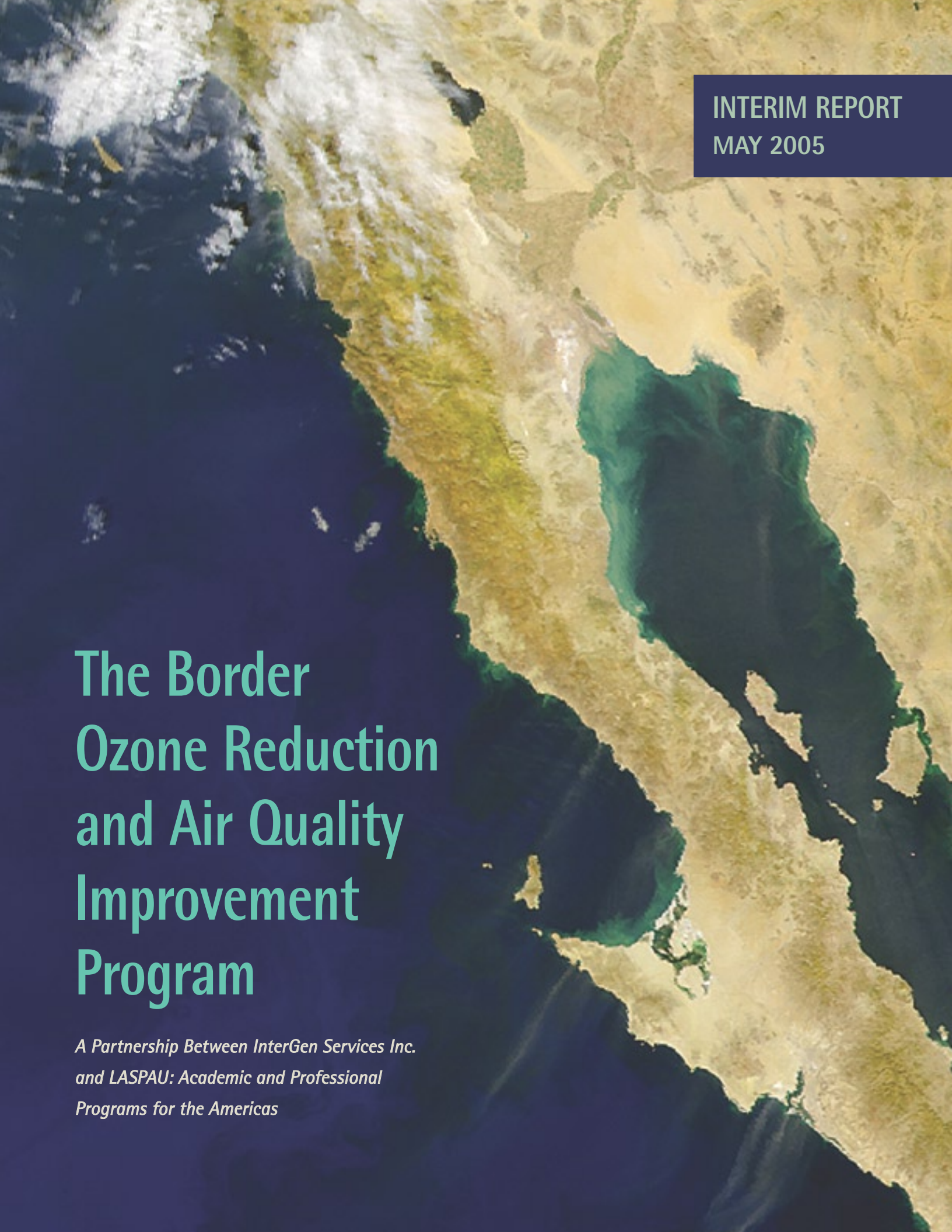

INTERIM REPORT
MAY 2005

The Border Ozone Reduction and Air Quality Improvement Program

A Partnership Between InterGen Services Inc. and LASPAU: Academic and Professional Programs for the Americas

CORBIS

The Border Ozone Reduction and Air Quality Improvement Program

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A partnership between industry and academia promises air quality improvements for the border region.

Straddling the border between Mexico and the United States, the region encompassing Imperial County, California, and Mexicali, Baja California, stands at a crossroads. Over the last ten years, Mexicali has been one of the fastest-growing cities in Mexico in terms of industrial development, job creation, and energy demand. The resulting increase in air pollution and environmental degradation presents tremendous challenges as well as opportunities for achieving sustainable and socially responsible economic growth.

The World Bank estimates that the costs associated with environmental degradation represent nearly 10%[1] of Mexico's Gross Domestic Product; energy depletion alone accounts for 4%.[2] According to a report on air quality in Mexicali issued by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT), the Mexican environmental agency, ozone-causing pollutants and fine suspended particulate matter have reached critical levels. Similar reports from the U.S. Environmental Protection Agency and the State of California confirm this data. Harmful contaminants in the region stem from a number of sources, including motor vehicles, unpaved roads, farms, power plants, and factories. These contaminants have severe consequences for the environment in the Mexicali and Imperial Valley region and the health of its one million citizens.

COURTESY NASA/JPL-CALTECH

A satellite image of the Calexico–Mexicali region. The red areas indicate agricultural activity, a contributing factor to air pollution on both sides of the border.

La Rosita Power Generation Facility

Industrial development in the Imperial Valley–Mexicali region has contributed to increased demand for electrical power on both sides of the border. In 2001, to meet this demand in the state of Baja California, InterGen, a global energy provider with 17 facilities in 9 countries, was selected by the government of Mexico to build the La Rosita power generation plant. The original design was expanded in 2002, when energy shortages became critical, to allow for the export of 50% of the energy to the state of California. The plant is located in Mexicali, seven miles from the California border.

La Rosita is a highly efficient gas-fired, combined-cycle power generation facility that meets or exceeds all World Bank and Mexican federal standards for air quality. It is among the cleanest facilities built to date in North America, setting new standards for environmental responsibility. For example, reclaimed municipal sewage is cleaned and processed to provide cooling water for the plant, preserving surface or ground water for other community uses. The plant is also one of only two facilities in Mexico that is fitted with a selective catalytic reduction (SCR) system, a state-of-the-art emissions control technology.

DAVID McNEW / GETTY IMAGES

Traffic idles on the Mexicali side of the U.S.–Mexico border crossing in March 2005.

InterGen Partners with LASPAU

Early on, InterGen recognized the air quality challenges faced by the Imperial Valley and Mexicali region. Regulatory, economic, and geographic factors on both sides of the border have a significant impact on air pollution and, correspondingly, on the health of border residents. InterGen felt that a scientifically based approach would be the most effective way to address these issues.

The resulting effort, the Border Ozone Reduction and Air Quality Improvement Program, is an innovative way to investigate and implement effective, scientifically based and measurable methods to reduce ozone creation and improve air quality in the border region. The program awards applied research grants to environmental and social scientists on both sides of the border. It also addresses cross-border policy issues such as shared environmental standards and the purchase of emission reduction offsets or other mitigation efforts that achieve a similar benefit. The $2 million initiative is funded by a seed grant from InterGen to LASPAU: Academic and Professional Programs for the Americas, a nonprofit organization affiliated with Harvard University.

One of the most important results of LASPAU's work in the last 40 years has been its contribution to the scientific and technological infrastructure of Latin American and Caribbean universities and research institutions. LASPAU-administered scholarship programs sponsored by U.S. and Latin American government agencies, academic institutions, multilateral banks, foundations, and corporations have provided grants for study and research to over 16,000 individuals

Scientific Advisory Board

Enrique Carlos Blancas de la Cruz, Rector of the CETYS University System, Centro de Enseñanza Técnica y Superior (CETYS)

Paul Ganster, Chairman of the Management Committee, Southwest Consortium for Environmental Research and Policy (SCERP) and Director, Institute for Regional Studies of the Californias, San Diego State University

Daniel J. Jacob, Vasco McCoy Family Professor of Atmospheric Chemistry and Environmental Engineering, Harvard University

Helen Ingram, Professor of Planning, Policy, and Design and Political Science and Warmington Chair in the Social Ecology of Peace and International Cooperation, University of California, Irvine

Mario Martínez García, General Director, Centro de Investigaciones Biológicas del Noroeste (CIBNOR), Consejo Nacional de Ciencia y Tecnología (CONACYT)

Martín Medina Martínez, Professor, Estudios Urbanos y del Medio Ambiente, El Colegio de la Frontera Norte

from Latin America and the Caribbean. Since 1992, LASPAU has implemented a series of programs supporting sustainable development. Nearly all program alumni have returned to their countries and most work in the natural, applied, and social sciences. InterGen recognized that this network was exactly what was needed in order to launch the Border Ozone Reduction and Air Quality Improvement Program.

Scientific Advisory Board

LASPAU began its work on behalf of the program in 2002 by identifying and selecting an independent scientific advisory board from among its network of academic and scientific contacts. Mario Molina, a Nobel laureate and a professor in the Department of Chemistry and Biochemistry and the Center for Atmospheric Sciences of the Scripps Institution of Oceanography at the University of California, San Diego, helped launch the program and recruit the board members.

Six leading academics from the United States and Mexico with expertise in science and the environment comprise the Board. It operates independently of InterGen, adding to the credibility of the program in an environment where power generators and the environmental community are often at odds. The Scientific Advisory Board provides overall program guidance and makes all decisions regarding grant awards.

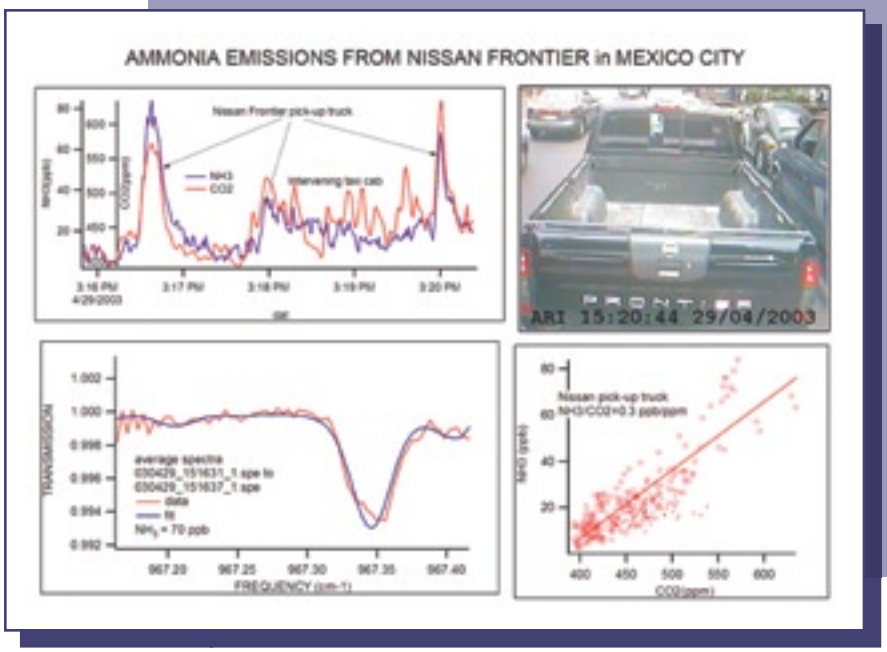
Assessment of Current Air Quality

Emissions inventories are a key component of air quality improvement programs. To fill the gaps in knowledge about air quality in the region and to inform decisions on the best use of grant funds, the Scientific Advisory Board selected Alberto Mendoza of the Center for Environmental Quality at the Tecnológico de Monterrey to conduct a comprehensive survey of current air conditions.

Mendoza is carrying out the 27-month assessment with a binational team of researchers. The project has already produced a catalog of research available on air quality in the region. Current activities include identifying pollutants transported to the border region from major urban centers and characterizing pollutant emissions from stationary and mobile sources (see pages 6–7). Baseline information provided by the survey will assist future work on air quality in the region.

Applied Research Grants to Improve Air Quality

The principal function of the Scientific Advisory Board is to stimulate the development of new knowledge about air quality problems in Mexicali and to encourage practical ways to address them. The Board's first task was to establish a grant program that includes a peer review process and to invite proposals from a large cross-section of institutions on both sides of the border. Successful proposals set out to facilitate partnerships between academia and the industrial, civic, and government sectors, with the shared goal of improving air quality in the border region. The Board awarded the first group of applied research grants in March 2004 (see pages 8–15) and the second group of grants in February 2005 (see page 16). Grants are awarded for a maximum of $80,000.



The Aerodyne mobile laboratory (above) used in Alberto Mendoza's study of emissions is able to take readings of particulate matter from both stationary and mobile sources of pollutants. As it travels around an area, the lab can follow and photograph vehicles, collecting and analyzing their emissions in real time without disrupting traffic flow. The mobile laboratory data at left, showing readings from a Nissan Frontier, are from a 2003 air quality assessment in Mexico City. Similar data are currently being obtained by Mendoza in Mexicali.

Industry–Academia Partnerships to Address Environmental Issues

InterGen's grant to LASPAU is a new approach to collaborative efforts between academic researchers and corporations to address environmental concerns. The program is an integral part of the La Rosita business plan that provides an opportunity for applied research with beneficial and lasting results in a region where air pollution is a major issue. LASPAU and InterGen are seeking other sources of support to expand the program beyond the original seed grant.

Notes

[1] Giugale, Marcelo M., Oliver Lafourcade, and Vinh H. Nguyen (eds.). 2001. *Mexico: A Comprehensive Development Agenda for the New Era*. Washington, DC: World Bank.

[2] *The Little Green Data Book 2001*. Washington, DC: World Bank.

Mexicali–Imperial Valley Air Quality Modeling and Monitoring Project

To ensure that emissions inventories of the Mexicali–Imperial Valley border region are complete and up-to-date, the Border Ozone Program funded a comprehensive survey of air quality in the region. Alberto Mendoza of the Tecnológico de Monterrey (the Tec) is conducting the project in conjunction with a team of researchers from the Tec, Aerodyne Research, Inc., the Georgia Institute of Technology, the Massachusetts Institute of Technology, and the Universidad Autónoma de Baja California.

The team is focusing on the Mexicali–Imperial Valley region in order to study pollution dynamics along the U.S.–Mexico border. They are also observing surrounding areas in order to identify pollutants transported from major urban centers (such as Tijuana in Mexico and Los Angeles in the United States) and point sources (such as feed lots) that are close enough to impact the air quality of the valley.

The project has three main components:

- Cataloging and examining the substantial work already undertaken by U.S. and Mexican researchers in previous air quality studies involving the Mexicali–Imperial Valley region

Alberto Mendoza

Alberto Mendoza is an associate professor in the Department of Chemical Engineering at the Tecnológico de Monterrey in Monterrey, Mexico. He also serves as director of the Clean Technology Group at the Tec's Center for Environmental Quality.

Mendoza's research focus is on air pollution science and engineering, particularly in the areas of air quality modeling, emissions inventory assessment, ambient air sampling, and control strategy design. He has participated in a number of air quality projects, such as the Southern Appalachian Mountain Initiative, a program to analyze and reduce the adverse effects of human-induced air pollution in the Appalachian Mountains, and a joint project with the University of Texas at Austin that assesses emissions from wildfires in northeastern Mexico. He has also worked on two Mexico–U.S. border air quality efforts examining transboundary air pollution in the Mexicali–Imperial Valley region. In 2002, Mendoza was recognized as a National Researcher Level 1 by Mexico's National Council for Science and Technology (CONACYT).

Mendoza is an active member of several professional organizations, including the Mexican Institute of Chemical Engineers (IMIQ), the Air and Waste Management Association (A&WMA), and the American Geophysical Union. He has published technical papers in journals such as *Atmospheric Environment, Journal of the Air and Waste Management Association,* and *Environmental Science and Technology.* He has also authored or co-authored more than 30 papers presented at specialized conferences organized by institutions such as the American Meteorological Society, the North American Regional Strategy for the Study of Tropospheric Ozone, the American Association for Aerosol Research, the American Academy of Sciences, CONACYT, A&WMA, and IMIQ.

Mendoza holds a doctoral degree in environmental engineering from the Georgia Institute of Technology. He received both an M.S. in environmental engineering and a B.S. in chemical engineering from the Tec.

- Conducting an in-depth source-receptor study to identify pollutants transported to the border region from major urban centers in the United States and Mexico
- Characterizing emissions from stationary and mobile sources using a high-tech mobile unit already employed in Mexico City that detects the pollutants that are the most harmful to human health

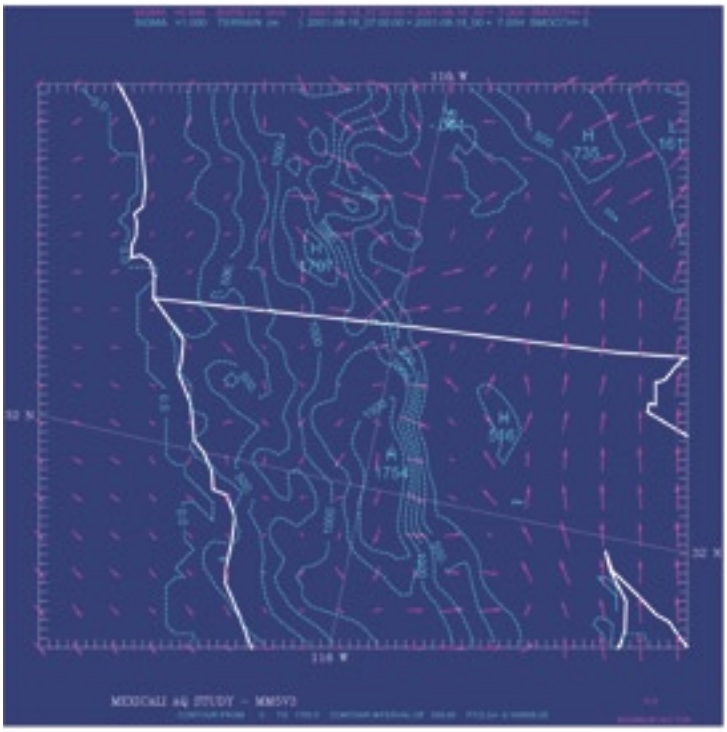
The study addresses research questions that will define standards in air quality policies between Mexico and the United States, such as:

- What is the chemical composition of the atmosphere in the region?
- What are the significant sources (local and regional) contributing to current air quality degradation?
- What are the specific emission profiles and levels from mobile sources and primary industrial sources?
- How does cross-border movement of air masses impact the air quality on each side of the border?
- What are the best emission control strategies that will result in air quality improvement?

Progress over the first year of the grant has been significant. Mendoza and his team have produced a catalogue of the research already conducted in the region and made it available to the public through the project's website.[1]

Based on preliminary estimates from the Mexico National Emissions Inventory project and updated estimates from the Instituto Nacional de Ecología, significant emissions modeling for the region began in 2004 and continues in 2005. Meteorological modeling has also been conducted using the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5).

To complement the modeling effort, an observational program was also developed to improve understanding of the main sources of regional air pollutants. Mendoza and his team designed and carried out a four-week monitoring campaign in November and December 2004. Low volume stationary monitors were deployed at three different sites in Mexicali, and



Alberto Mendoza's team used meteorological modeling to analyze wind patterns on both sides of the U.S.–Mexico border, defined by the horizontal line in the center of this topographical image. The Mexicali–Imperial Valley region is the flat area to the right. Arrows indicate wind direction at 7 a.m. on August 18, 2001.

samples of $PM_{2.5}$ (particulate matter with a diameter of less than 2.5 microns) were then analyzed for various chemical and mass contents. The team also conducted an observational program using a mobile laboratory in April 2005.

Mendoza continues working on emissions and meteorological modeling and will begin preparing the setup of the air quality model. Analysis of the collected data is ongoing.

Mendoza expects his research will contribute to continuing efforts to reduce air pollution in the region.

Notes

[1] http://www.mty.itesm.mx/dia/centros/cca/lcai/mexicali/index1.html

Understanding Environmental Culture and Sustainable Behavior in the Mexicali–Calexico Region

Studies such as those conducted by the Southwest Consortium for Environmental Research and Policy have shown that people's everyday routines contribute greatly to pollution.[1] In the Mexicali–Calexico region, poorly maintained vehicles contribute to the levels of carbon monoxides, nitrogen oxides, and hydrocarbons in the air. Burning of trash, tires, and other materials is a source of particulate matter, sulfur dioxides, and carbon monoxides. Driving on unpaved roads, illegal dumping, and other common behaviors of individuals are additional contributors to particulate matter. The resulting air pollution is linked to high rates of asthma and respiratory diseases on both sides of the border.

The willingness of residents to engage in environmentally beneficial behavior is crucial to improving air quality. Education programs can help, but such programs are most successfully developed and implemented when the local culture is first analyzed and understood. Kimberly Collins of San Diego State University received a grant from the Border Ozone Program to develop an education program to improve air quality that takes into account the social behaviors, beliefs, interactions, and material productions of residents of the Mexicali–Calexico region.

During the first year, Collins and her project team focused on understanding the environmental culture in the region. A qualitative and quantitative questionnaire that included questions related to environmental behavior and awareness was assembled and tested in the community for its appropriateness. In the fall of 2004, 20 individuals in Calexico and 45 individuals in Mexicali were interviewed for one-and-a-half to two hours each. These individuals were selected randomly

Kimberly Collins

Kimberly Collins is the director of the California Center for Border and Regional Economic Studies (CCBRES), located at the Imperial Valley campus of San Diego State University (SDSU). The mission of CCBRES is to inform individuals and public and private decision-makers about demographic, economic, and social trends in the Imperial Valley and the western U.S.–Mexico border region.

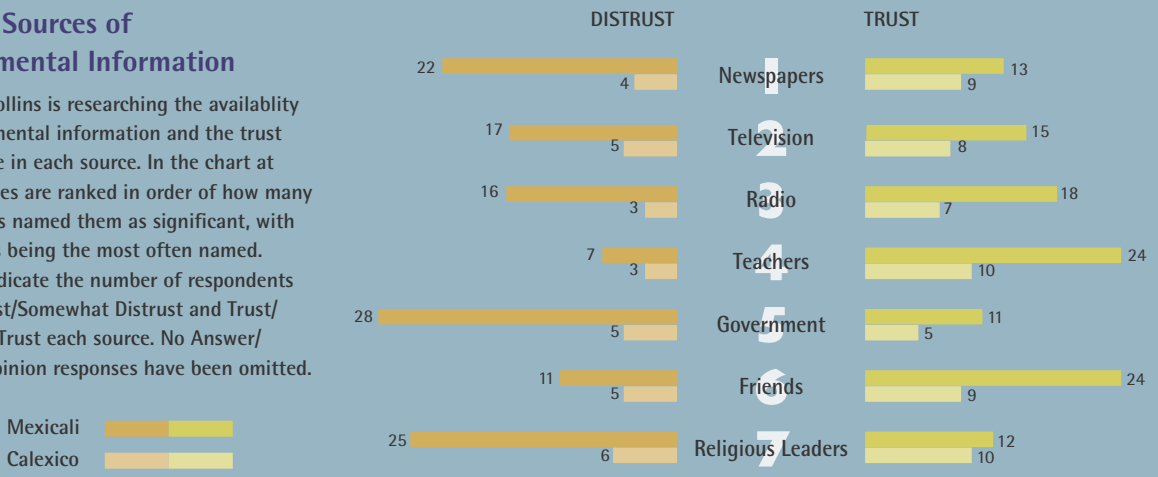
Collins's research has been focused on quality-of-life issues in the Mexicali–Imperial Valley region. As part of this focus, the staff of CCBRES, along with colleagues from the Universidad Autónoma de Baja California (UABC), has been developing a quantitative model to analyze quality of life in the Imperial Valley and Mexicali. Collins is also working with researchers from UABC and Arizona State University to conduct a quality-of-life survey in the Mexicali–Imperial Valley region and will soon begin work in San Luis, Yuma, and San Luis Río Colorado, Sonora.

Collins is currently the U.S. chair of the Imperial–Mexicali Air Quality Taskforce, the founder and chairwoman of the Calexico Carnegie Technology Center, and a member of Calexico's Historical Commission. She previously served as chair of the Imperial County Overall Economic Development Commission and the Imperial County Enterprise Community Subcommittee on Education and Quality of Life.

Collins is working on a doctorate in applied social sciences/public administration from El Colegio de la Frontera Norte. She received a master's degree in political science with a focus on international relations from San Diego State University and a B.A. in political science from SDSU.

Trust in Sources of Environmental Information

Kimberly Collins is researching the availablity of environmental information and the trust people have in each source. In the chart at right, sources are ranked in order of how many respondents named them as significant, with newspapers being the most often named. The bars indicate the number of respondents who Distrust/Somewhat Distrust and Trust/ Somewhat Trust each source. No Answer/ Without Opinion responses have been omitted.



and represented professional and middle-class households in the region.[2]

The project team is in the process of analyzing the results from these interviews, but preliminary findings include the following:

- The majority of those interviewed recognized that environmental problems were worse in Mexicali than in Calexico
- Less than half of the respondents had been contacted by someone regarding environmental issues
- The most common sources of environmental information were newspapers and television
- Information from government and religious leaders was the least trusted and information received from teachers and friends was the most trusted

During the second phase of the project, Collins and her team will develop culturally sensitive educational materials that explain air pollution and measures that local residents can take to improve air quality. The products will be tested through a round of focus groups and introduced to residents at a community fair in a middle-class neighborhood selected for the willingness of local businesses to be part of an environmental pilot project. After the conclusion of the fair, the project team will work directly with the municipality to more broadly disseminate the educational materials through local businesses and organizations over a period of six months.

The final stage of the project will involve an additional set of focus groups to obtain results from residents. If behavioral changes have occurred and individuals are shown to be more aware of the environment, the researchers will work with the municipality and businesses to transfer the methodology so that the campaign can be conducted on a larger scale within the region.

Enforcement is one tool to change individual behaviors, but it is more desirable and less demanding on local resources for people to voluntarily comply with regulations. Understanding individuals—their perceptions, values, and practices—is key to developing and implementing a program to encourage behavioral change. Collins and her team hope that by understanding the culture in the Mexicali–Imperial Valley region and by promoting activities that raise the awareness of residents, environmentally beneficial behavior will increase, thereby improving air quality.

Notes

[1] Ed Sadalla, Tod Swanson, and Jose Velasco. 1998. *Residential Behavior and Environmental Hazards in Arizona-Sonora Colonias*. SCERP. www.scerp.org

[2] The reason for selecting professional and middle-class households was twofold. First, when developing actions that residents can undertake to improve the environment, households that are not struggling to survive and living at the poverty level will have a better chance of modifying their behavior. Second, the resources available to the project team did not allow for a larger sampling of the population.

Developing a Pollen Map of Mexicali

Mexicali and the Imperial Valley have similar environmental regulations for carbon monoxide (CO), ozone (O_3), and coarse particulate matter (PM_{10}). However, because of their geographic, physical, and urban characteristics, and the prevalence of agricultural production in the region, neither area is in compliance with these regulations. The presence of air pollutants contributes to allergies and respiratory diseases among the population. Another factor that causes health problems is the presence of pollens produced by local flora as well as those brought to the region by wind currents.

The Imperial Valley relies on an existing pollen map, extrapolated from a San Diego monitoring model, to aid officials in predicting and warning the public about pollen levels as well as to help in diagnosing and treating allergies. Mexicali, like the Imperial Valley, has an unusually high number of allergic residents, particularly children, yet it has no pollen map or system of pollen monitoring to help those who suffer from allergies. To meet this need, Margarito Quintero Núñez of the Universidad Autónoma de Baja California received funding from the Border Ozone Program to monitor and map pollen sources in the Mexicali region.

Quintero conducted a one-year study, taking daily pollen count samples to test for volume and type of pollen. Prior to taking the samples, allergists assisted Quintero and his team to determine where to position four pollen sample collectors. Decisions were based on which areas of Mexicali registered the highest rates of allergies and respiratory diseases among the population.

In the second phase of the project, the data will be classified by time of year and types of pollen, defining which pollens are present in different areas at specific times of the year.

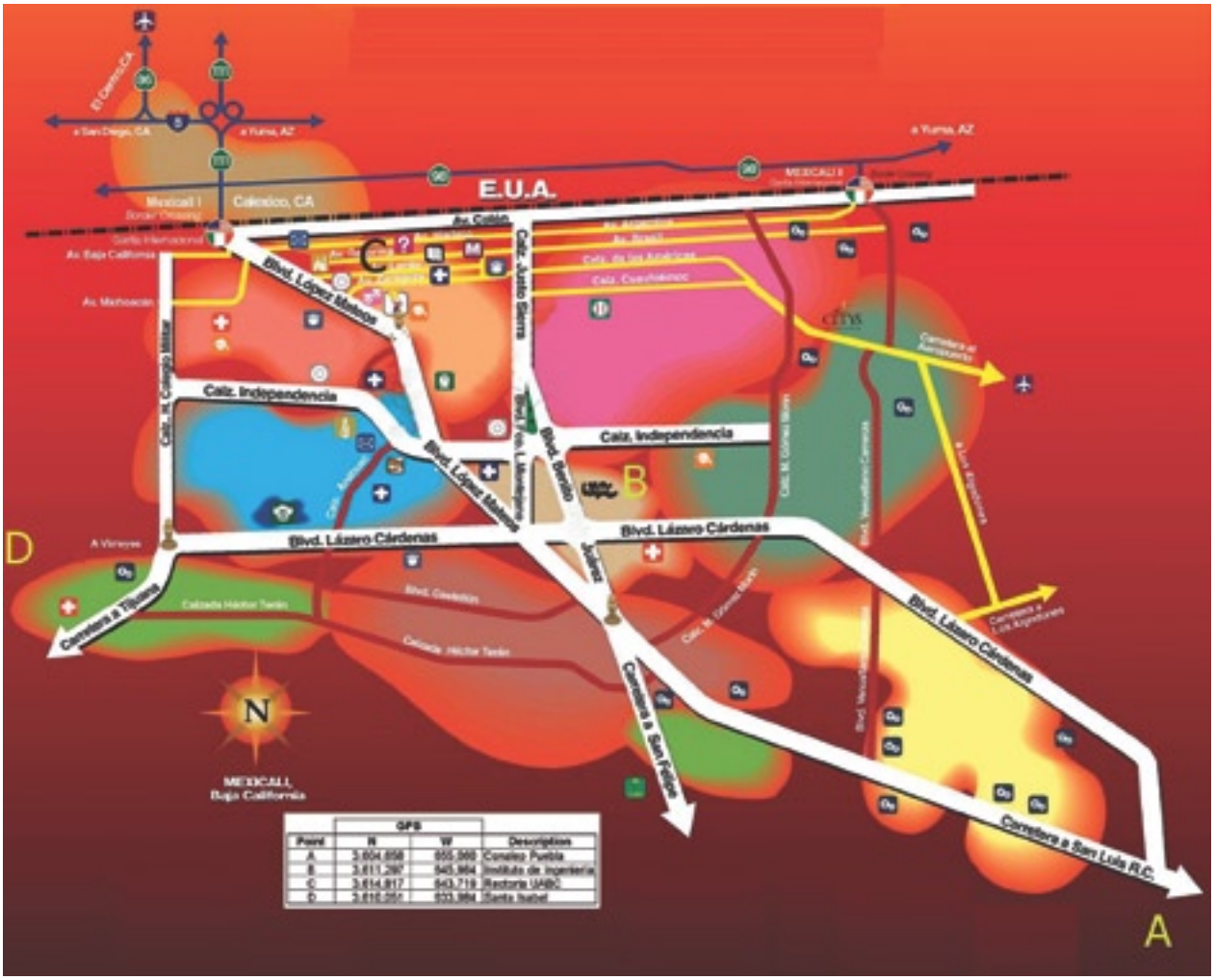
Margarito Quintero Núñez

As a researcher and professor at the Institute of Engineering of the Universidad Autónoma de Baja California (UABC) in Mexicali since 1985, Margarito Quintero Núñez has carried out significant research in the field of energy and the environment. Since 1995, he has worked on collaborative scientific projects sponsored by the Southwest Consortium for Environmental Research and Policy (SCERP).

In addition to his current work at UABC, Quintero has taught at many academic institutions, including the Universidad Nacional Autónoma de México (UNAM), the Centro de Investigaciones en Máquinas Herramientas, the Instituto Politécnico Nacional, the Universidad Autónoma Metropolitana, the Instituto Tecnológico de Mexicali, and El Colegio de la Frontera Norte. He also served as an associate lecturer at San Diego State University–Imperial Valley as a component of a Fulbright–Garcia Robles research scholarship in 2000.

Quintero has been an active member of scientific and technological organizations such as the Committee for the Evaluation of Engineering and Technology Programs in Higher Education, the National Council of Science and Technology (CONACYT), the National System of Researchers (SNI), and the Mexican Institute of Chemical Engineers. He has written numerous papers for scientific journals and books, including recent articles on his air quality research published in the SCERP Monograph Series.

Quintero obtained a doctoral degree in applied industrial metallurgy from the University of Birmingham in England and a B.S. in chemical engineering from UNAM.



Margarito Quintero placed four pollen count detectors in Mexicali, shown on the map above as A, B, C, and D, in order to determine variations in allergens between different areas of the city and times of year.

Through his work, Quintero expects to help identify the specific allergens that affect allergy sufferers and establish specialized treatments for patients, including preventative therapies, therefore lowering the cost of treatment. He will make his results available to a variety of health institutions in the Mexicali area, so they may better treat patients, and will also compile the results in a report to be disseminated at conferences and submitted for publication in scientific journals.

His efforts will enable local health officials to minimize the harmful effects of high pollen counts, especially among children and those suffering from respiratory diseases.

Respiratory Diseases and Air Pollutants in the Mexicali–Imperial Valley Region

While it is well known that air quality in the Mexicali–Imperial Valley region has negative effects on public health, little is known about which pollutants actually are affecting people's respiratory systems and which respiratory diseases are having the most damaging effect on the local population. Marco Antonio Reyna Carranza of the Universidad Autónoma de Baja California (UABC) is conducting research on the correlation between certain air pollutants and respiratory diseases in the region. The project, which is being carried out in conjunction with the University of California, San Diego, and the Instituto de Servicios de Salud Pública del Estado de Baja California (ISESALUD), is designed to obtain quantifiable data that can be used on both sides of the border.

Reyna's team is analyzing meteorological and air pollutant data gathered at various monitoring stations in the region, while at the same time cross-referencing these results with clinical data on respiratory diseases from the last four years. The project has six central goals:

- Evaluating the seasonal and yearly incidents of air pollutants in the region
- Assessing the occurrence of asthma, pneumonia, bronchitis, and other acute respiratory diseases by year and by season
- Determining if there is a correlation between air pollutants and respiratory diseases within the parameters of time and season
- Determining which air pollutants contribute to respiratory diseases
- Ascertaining to what degree these respiratory diseases are affected by air pollutants

Marco Antonio Reyna Carranza

Marco Antonio Reyna Carranza, a professor and researcher at the Institute of Engineering of the Universidad Autónoma de Baja California (UABC) in Mexicali, has formulated and carried out a diverse array of independent and collaborative biomedical engineering and environmental health research projects. Reyna's research topics include experimentally relevant analyses of non-invasive methods of tachycardia risk prediction in postinfarcted patients, air quality and its effects on population health, and time-frequency algorithms for improving the late potentials detection in high resolution electrocardiography analysis. In addition, he has conducted statistical analyses of biomedical databases and has helped to design hardware for physiological signal processing and analysis.

Reyna has worked in close collaboration with researchers in the United States and Mexico on projects financed by organizations such as the Southwest Consortium for Environmental Research and Policy (SCERP), San Diego State University (SDSU), the Consejo Nacional de Ciencia y Tecnología (CONACYT), and the Sistema de Investigación del Estado de Baja California (SINVE). He has also collaborated with a variety of researchers from SDSU–Imperial Valley to organize environmental health forums and conferences on the Baja California–California border region.

Reyna obtained a doctoral degree in bioengineering from the Universitat Politècnica de Catalunya in Barcelona, Spain, an M.S. in biomedical engineering from the Universidad Autónoma Metropolitana–Iztapalapa in Mexico D.F., and a bachelor's degree in electrical engineering from UABC.

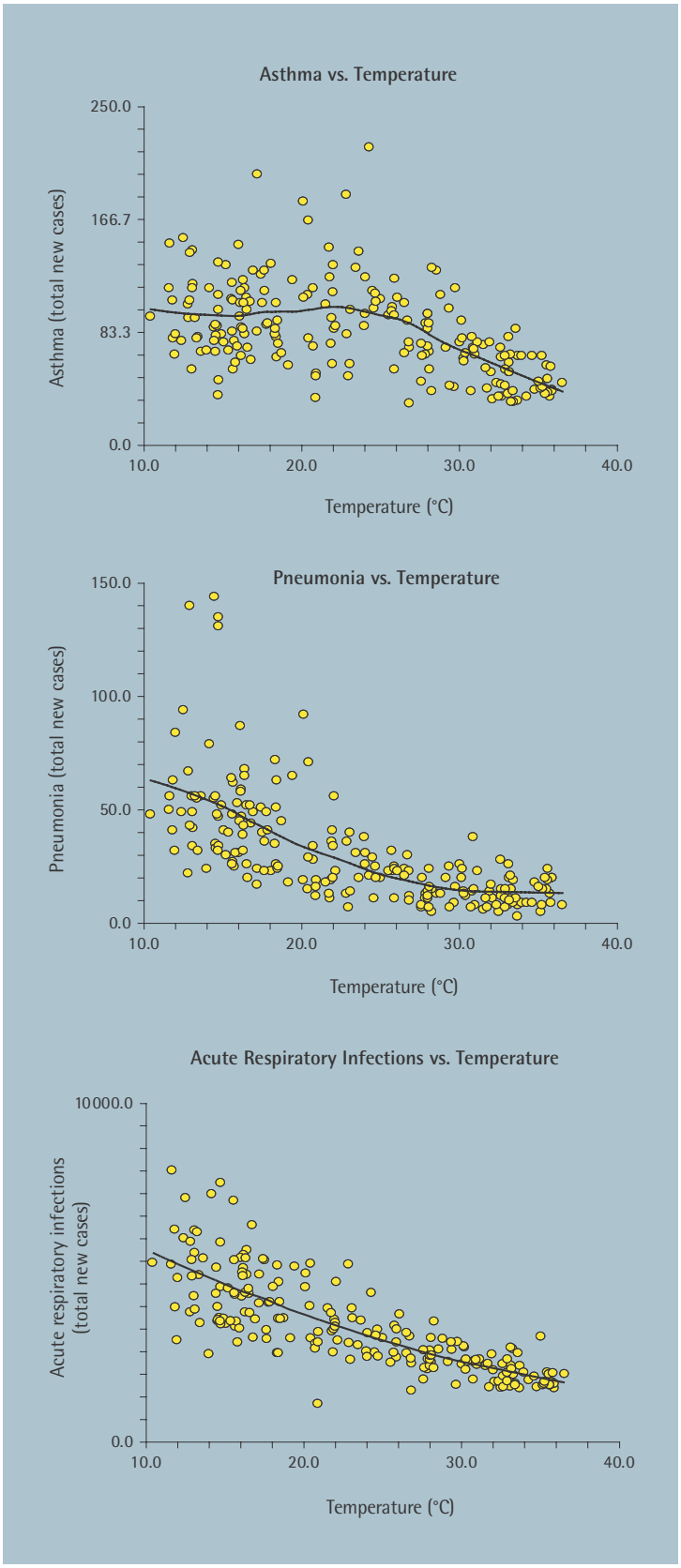
- Predicting what effects these pollutants will have in the future, taking into account factors such as temperature and humidity

ISESALUD reports that the number of patients hospitalized for respiratory infections in the region is increasing, particularly among children and the elderly. Each year, there are 4,700 new cases of asthma, nearly 2,000 new cases of pneumonia, and approximately 181,000 new cases of acute respiratory diseases. Studies conducted by the Environmental Studies Department at UABC show that all of these cases are a direct or indirect consequence of the three main air pollutants in the region: ozone, carbon monoxide, and PM_{10}.

During the first year of the project, Reyna and his team created two databases of meteorological, chemical, and clinical data gathered in the region between 1997 and 2000. The first database contains meteorological variables such as temperature and humidity, as well as occurrences of the main air pollutants. The second database chronicles the incidence of respiratory diseases in the local population. These databases have been sorted by season and by year in order to establish qualitative and quantitative correlation through time. Researchers are now examining the newly sorted data to determine to what extent respiratory diseases are correlated to temperature, humidity, and air pollutants.

The second part of the project involves building a dynamic prediction model. This will be done by using three regression models—a Poisson log-linear regression model, a dynamic regression model, and an ARIMA model—that will better explain the delay between respiratory diseases and meteorological and polluting factors. These models will then be integrated using STELLA, a software program that will provide researchers and decision-makers with a user-friendly way of accessing the data.

The team hopes that analyzing the effects these variables have on each other will produce reliable data that will eventually influence both environmental and public health policy.



Marco Antonio Reyna's research shows a general negative relationship between illnesses and weekly average temperature. Reyna is studying the effects of several variables on the prevalence of respiratory diseases.

Inventory of Emissions from Mobile Sources in the Mexicali Metropolitan Area

In Mexicali, a city with nearly 870,000 inhabitants,[1] more than 45% of the vehicles are models from 1980 or before, 48% are models from 1981 to 1990, and only 3% are from 1991 or later.[2] Increased levels of harmful emissions from older vehicles are compounded by chronic delays at border crossings.

Dzoara Damaris Tejeda Honstein of the Tecnológico de Monterrey, Campus Estado de México, received a grant from the Border Ozone Program to investigate emissions of nitrogen oxides (NO_x), carbon monoxide (CO), and other ozone precursors related to traffic patterns and vehicle types in Mexicali.

Tejeda's goal was to continue and expand upon research presented in a 1996 inventory of pollutant emissions in the Mexicali region.[3] The inventory, conducted by the National Institute of Ecology and sponsored by the Western Governor's Association, identified sources of emissions in the region and reported emissions by vehicle category. Tejeda identified the following weaknesses in the 1996 inventory while outlining the goals of her own project: the inventory did not report on emissions by time of day or day of the week, and the information was not georeferenced. Additionally, no new data had been collected since the study, leaving policymakers in the region without current information on emissions.

In order to create a more thorough follow-up to the 1996 study, Tejeda collected data during June of 2004 to create an emissions inventory from mobile sources in the Mexicali area, classifying information by time of day, day of the week, vehicle flow, and geographic area. Additionally, Tejeda examined emissions from different classifications of vehicles, including private vehicles, pick-up trucks, buses, public transportation vehicles, vehicles with light loads, and vehicles with heavy loads.

By selecting 22 roadways representative of typical traffic patterns in the area and by choosing time

Dzoara Damaris Tejeda Honstein

As air quality coordinator for the Environmental Quality Research Center at the Tecnológico de Monterrey, Campus Estado de Mexico, Dzoara Damaris Tejeda Honstein has focused the center's air quality research on three areas: atmospheric emissions inventories, atmospheric modeling, and environmental indicators. Through a project funded by CONACYT and SEMARNAT, Tejeda and her colleagues at the Tec have been developing new ways to estimate emissions from both mobile and fixed sources. She is currently working on several other research projects, all funded by the Tec, including investigations of traffic patterns at the local level and the speciation of fixed source hydrocarbons.

Tejeda also serves as the air quality coordinator for the Mexican Sustainable Development Board and is a member of the Municipal Committee for Environmental Protection of the Municipality of Naucalpan in Mexico.

Tejeda is currently completing her doctoral work in atmospheric physics at the Universidad Nacional Autónoma de México, where her research has a similar focus to her work at the Tec. She has been developing aerosol models for the Zona Metropolitana del Valle de México, as well as new ways of estimating emissions inventory results. She received an M.S. in chemical engineering with a focus on air quality from the Tecnológico de Monterrey, Campus Estado de Mexico.

A sample of CO emissions in kilograms per hour was taken at 7 a.m. on different roadways in Mexicali (above). The photographs at right show Dzoara Tejeda's team setting up a system to monitor traffic flow with the help of local police.

periods to collect data that represented normal traffic activity, Tejeda was able to accumulate data for emissions of hydrocarbons (HC), CO, and NO_x that would assist in the creation of future laws and programs to regulate contaminating emissions.

HC, CO, and NO_x all have damaging effects on human health. For example, it is known that NO_x can reduce lung function and damage the lung tissue of children, those who work or exercise outdoors, and people with respiratory diseases such as asthma, emphysema, and bronchitis. In addition, NO_x contributes to the deterioration of water quality, to global warming, and to the formation of acid rain. It also can affect visibility and vegetation growth.

Tejeda's report on her research includes recommendations for policymakers. She suggests they consider her data on the distribution of harmful emissions when creating programs or policies to control pollutants and traffic flow in the region.

Notes

[1] INEGI, resultados definitivos del XII censo general de población y vivienda.

[2] INE, Gobierno de Baja California. 1999. *Programa para Mejorar la Calidad del Aire de Mexicali 2000–2005*. Mexicali, B.C. México.

[3] Inventario de emisiones de Mexicali 1996.

Grants Awarded in 2005

In the second round of funding for the Border Ozone Reduction and Air Quality Improvement Program, seven grants were awarded to researchers at Mexican and U.S. institutions whose projects address the gap between environmental science and public policy in the effort to reduce air pollution in the Mexicali–Imperial Valley region.

Marco Antonio Carrillo Maza, director of graduate programs at the Centro de Enseñanza Técnica y Superior (CETYS), will develop a master's degree program in environmental management and sustainable growth. The new program will address the need for specialized applied research and will generate knowledge, networks, and synergies focused on environmental problems in the Imperial Valley and Mexicali.

Efrain C. Nieblas Ortiz, a researcher at the Universidad Autónoma de Baja California, will establish a binational plan for the Imperial Valley and Mexicali to reduce ozone production and improve border zone air quality. The plan will include a binational environmental district encompassing the Imperial Valley and Mexicali, an international environmental impact protocol, and an emission offset protocol.

STEPHANIE MAZE / CORBIS

Airborne contaminants are particularly damaging to the health of children, such as these young girls jumping rope in Calexico, California.

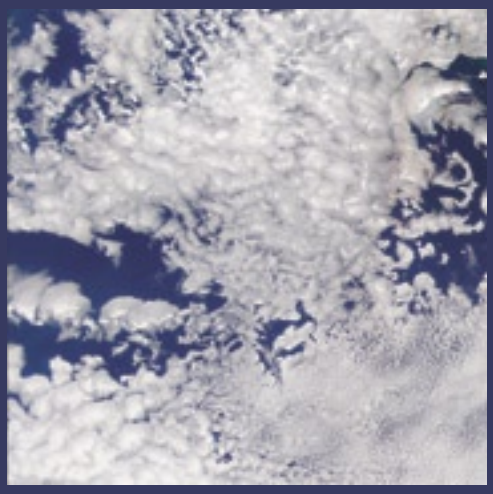
Alvaro Román Osornio Vargas, head of Environmental Health at the Universidad Nacional Autónoma de México and a medical investigator at the Instituto Nacional de Cancerología, will conduct an evaluation and composition analysis of airborne and soil particles collected in different zones of Mexicali. The results will help determine which suspended particles contribute most to the adverse health effects of atmospheric contamination so that control measures can be appropriately prioritized.

Marco Antonio Reyna Carranza, a professor and researcher at the Universidad Autónoma de Baja California, will continue his project to determine the relationship between airborne contaminants and respiratory diseases in order to provide a baseline for future efforts to improve binational environmental health policies (see page 12). In the second phase of his work, Reyna will design a prediction model for health officials.

Jesús Rivera Garibaldi, also a professor and researcher at the Universidad Autónoma de Baja California, will study the composition and concentration of volatile organic compound emissions in Mexicali in order to verify contaminated zones and establish emissions limits according to the production activities of specific industries.

Alan Sweedler, professor of physics and director of the Center for Energy Studies at San Diego State University, will create a model of pollutants that are indicators of air quality in the Mexicali and Imperial Valley region. He will conduct an in-depth analysis to reveal lesser-known methods of improving air quality in the region, and he plans to have the results integrated into air quality policy.

Rick Van Schoik, managing director of the Southwest Consortium for Environmental Research and Policy (SCERP), received funding for SCERP's 2005 annual conference, Border Institute VII: Transboundary Air Pollution and Binational Air Quality Management, held in Rio Rico, Arizona, in April. SCERP, a collaboration of five Mexican and five U.S. universities, conducts applied environmental research to guide policymaking in order to improve the quality of life of residents of the border region.



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