Final Performance Report:
Environmentally-Related Disease and Environmental Exposures in the California/Baja California Border Region

October 18, 2007

Grant #X4-96926301-0

Paul English, PhD, MPH, Principal Investigator
Environmental Health Investigations Branch
California Department of Public Health
Fiscal Agent: Public Health Institute
Contractor: Craig Wolff, MS

Table of Contents

List of Tables and Figures

I **Project Summary**

The objectives of this project were to (1) conduct an inventory and assessment of health, hazard, and exposure databases unique to the California/Baja California region which could be used in a border environmental and occupational health surveillance system; (2) conduct a review of Environmental Health Indicators for the California/Baja California border; and (3) develop a geographic information system (GIS) database warehouse and mapping tool of environmental and health data in a website for public access.

II **Inventory/Assessment of Health, Hazard, and Exposure databases**

We used the approach of Thacker et al (Figure 1) to define, hazard, exposure and health surveillance (tracking). Data involved in hazard tracking gives the user information that the agent is present in the environment and a route of exposure exists. These are commonly available data which are collected for regulatory requirements of pollutant emissions, for example. Exposure tracking occurs when an agent of concern reaches the target tissue; this commonly is defined as biomonitoring (levels of contaminants in human tissues, such as serum and urine). Health tracking provides information on when the agent produces an effect which is clinically apparent. Health tracking data may be found in disease registry databases, for example. Databases of each of these types of tracking available for the CA/Baja CA border region is described below:

A) Hazard Databases
    1. Air pollution (criteria and toxic pollutants)

Aerometric Data Analysis and Management System (ADAM)

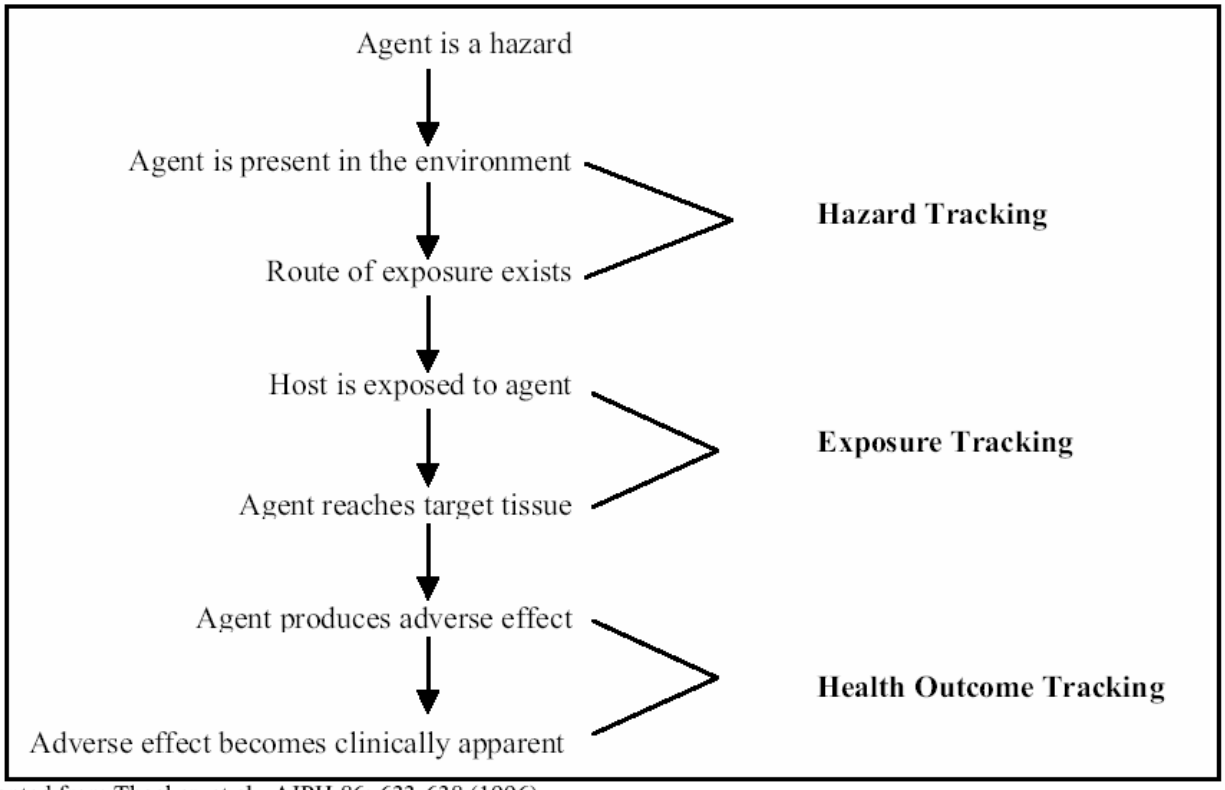
Description: The California Air Resources Board (CARB) routinely collects air quality information on criteria pollutants, including ozone, nitrogen dioxide, carbon monoxide, and particulate matter. There are 6 ARB monitoring stations in the Imperial Valley, 6 in the Mexicali, BC area; 8 in San Diego County and 6 in the Tijuana, BC area. Monitoring data are submitted and loaded into ADAM on an almost daily basis. The system receives approximately 6 million data values each year, and now contains about 180 million data values. The data on criteria air pollutants have been integrated into our Border GIS website (see section IV below). Air monitoring stations also collect data on toxic air contaminants such as volatile organic compounds (e.g. benzene, toluene); polycyclic aromatic compounds (e.g.benzo(a)pyrene); and metals (e.g. copper, aluminum) and meteorological data. This data is available from CARB, but it is not part of ADAM.

Strengths: Data can be used to assess trends and conformance with state and national air quality standards. ADAM uses pollutant IDs that are the same ones used in the U.S. EPA's ambient air quality data management system. The monitoring sites are located throughout the State. Database contains monitoring stations address and location information. Access to unofficial data is available within 2 – 4 months of collection. Historical data go back to the 1960s. ADAM includes no confidential data. There are plans to merge air quality data with emissions data in the future.

Weaknesses: Monitoring station coverage is greater in metropolitan areas. The density of the monitoring stations is not enough to provide accurate estimates of exposure for entire populations, but needs to be supplemented by statistical modeling, which is subject to error. CARB can provide meteorological and toxics data that is collected, however these data are not part of ADAM. Interpretation of data requires understanding of measurements and complex algorithms. There is an 18 month lag for the release of official data in July for entire previous year. Updates to data may occur 2 – 3 years after data are certified.

Web Source: http://www.arb.ca.gov/aqd/namslams/namslams.htm

Figure 1: Environmental Health Tracking



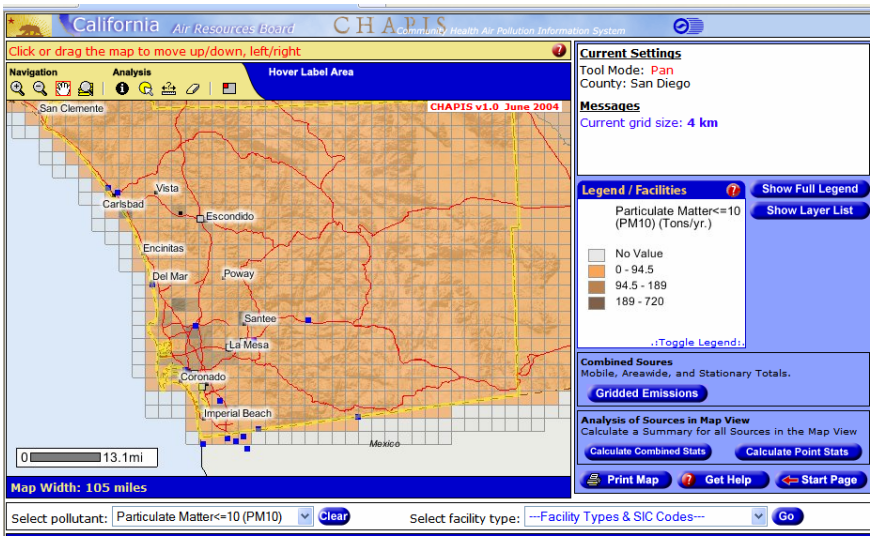
Adapted from Thacker, et al., AJPH 86: 633-638 (1996)
Note: 'Tracking' is substituted for 'surveillance', which appeared in the original publication in AJPH, for the purposes of this report.

Community Health Air Pollution Information System

Description: CARB has developed, with assistance of the California Environmental Health Tracking Program, a web-based mapping tool to analyze the spatial characteristics of California's Air Pollutant Emission Inventory, for emissions of traditional criteria air pollutants and key toxic air pollutants. This mapping tool displays point sources (such as industrial facilities), mobile source, and dispersed source emissions data. The Community Health Air Pollution Information System (CHAPIS) shows gridded estimates (4 km^2 for the

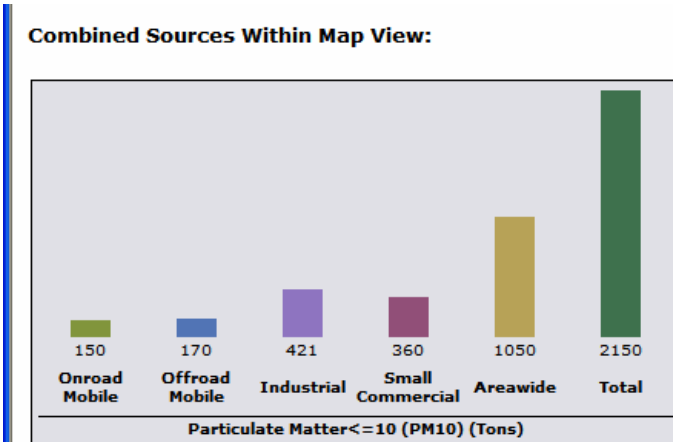
border counties) which are downsized from county-wide emission estimates for mobile, areawide (e.g. dispersed solvents, painting), and stationary source totals. Figure 2 shows gridded estimates for all mobile, areawide, and stationary sources for PM_{10} for the San Diego area.

Figure 2: Modeled levels of PM_{10} (tons/yr) in the San Diego Border Area, Community Health Air Pollution Information System, California Air Resources Board



CHAPIS also summarizes the proportion of different sources of the selected pollutant by type. For example, for the Imperial Valley, CHAPIS estimates 2150 tons of PM_{10}, with approximately half coming from areawide sources (Figure 3).

Figure 3: Sources of PM_{10} in the Imperial Valley, Community Health Air Pollution Information System, California Air Resources Board



Strengths: CHAPIS can display estimates of both criteria and toxic air pollution emissions, and estimates of pollution from both mobile and point sources.

Weaknesses: Mobile source pollutant estimates are downscaled from county estimates. Levels of reported emissions and modeling lacks temporal dimensions. The gridded modeling does not extend down into Mexico. CHAPIS does not contain all air pollution sources or all air pollutants, and emission estimates are based on average conditions.

Web source: http://www.arb.ca.gov/gismo/chapis_v01_6_1_04/

2. Traffic data

Highway Performance Monitoring System (HPMS)

Description: HPMS provides data that reflects the extent, condition, performance, use, and operating characteristics of the nation's highways. HPMS data is also used to assist the US EPA in monitoring air quality conformity. The provision of HPMS data is a cooperative effort with state highway agencies, local governments and metropolitan planning organizations. California Department of Transportation is responsible for HPMS in California and reports the data to the Federal Highway Administration. The information is collected on freeways, highways and major roads. The database includes annual average daily traffic (cars and trucks combined), limited information on truck flow by number of axles, number of lanes, parking, and many other variables pertaining to road operation and maintenance. HPMS is not a static entity but a dynamically changing live database, with traffic volume groups recalculated each year as annual traffic figures change.

Strengths: HPMS provides essential car and truck traffic counts for major California major highways which can be used for modeling and risk assessment. Data is available in a database ready for use in Geographic Information System. There are plans to identify specific geographic location of collection source in the future.

Weaknesses: No data are collected on non-State, locally maintained streets; these are collected by local jurisdictions. Therefore, there is no centralized database which contains a comprehensive inventory of all street traffic. Data is organized by road segments of widely varying length, not streets. Vehicle counts are not conducted yearly on all roads. Some vehicle counts are either estimates or extrapolations. In a GIS-ready layer, truck data is of poor quality. Better quality truck counts are available through a web-based query or an Excel spreadsheet by milepost only. Data are derived using complex algorithms. There is a 22 month lag for the release of official data.

Web Source: http://svhqsgi4.dot.ca.gov/hq/tsip/hpms/index.html

3. Border Vehicle Crossing Data

Description: Vehicle crossings are important for environmental health at the border, as increasing number of vehicle crossings are related to increased emissions of traffic-related pollutants. From 1995-2000, there was a 188% increase in northbound traffic at the California/Baja California border, with the majority of the increase coming from the Otay Mesa crossing (Table 1). Percentage increase slowed significantly in 2000-2005. Northbound border crossings have actually decreased at the Tecate and Calexico crossings.

Strengths: Provides a crude measure of traffic-related pollution at the California/Baja California border.
Weaknesses: Only northbound data are available since Mexico does not have easily accessible data.

Table 1: Northbound Vehicle Crossings at the California/Baja California Border, Selected Years 1995-2006

	1995	2000	2005	2006*	1995–2005 Percent Change	2000–2005 Percent Change
California	**12,224,347**	**31,148,705**	**35,146,154**	**20,011,499**	**187.5%**	**12.8%**
Andrade	534,389	606,863	729,637	399,503	36.5%	20.2%
Calexico	7,081,042	6,744,970	6,234,602	3,504,074	-12.0%	-7.6%
Calexico East	N/A	2,550,625	3,271,961	2,192,828	N/A	28.3%
Otay Mesa	3,549,378	4,845,348	6,672,994	3,452,561	88.0%	37.7%
San Ysidro	N/A	15,237,428	17,208,106	9,880,509	N/A	12.9%
Tecate	1,059,538	1,163,471	1,028,854	582,024	-2.9%	-11.6%

Source: U.S. Department of Transportation, Research and Innovative Technology Administration, Bureau of Transportation Statistics, Border Crossing/Entry Data; based on data from U.S. Department of Homeland Security, Customs and Border Protection, OMR database. Adapted from California Center for Border and Regional Economic Studies, CCBRES Bulletin, July/August 2007 Vol. 8, No. 7 & 8.

Web Source: http://www.ccbres.sdsu.edu/publications/bulletins/pdf/2007_Bulletins/8.7-8.pdf

4. Other Toxic Contaminants/Hazardous Waste

Toxic Release Inventory (TRI)

Description: In the TRI database, U.S. EPA collects information on releases of an estimated 650 chemicals and chemical categories from industrial facilities that meet certain criteria (number of employees, production or use of specified chemicals). Businesses report the locations and quantities of chemicals stored on-site to state and local governments. US EPA and the States annually collect data on releases and transfers of certain toxic chemicals from industrial facilities, and make the data available to the public in the TRI. Additional data on waste management and source reduction activities are reported under TRI as of 1990. The TRI also collects data from a specific set of industry sectors, including the manufacturing sector, metal mining, coal mining, electric utilities, petroleum terminals and bulk storage, chemical wholesalers, RCRA commercial hazardous waste treatment, and solvent recovery. Data is collected annually.

Strengths: TRI provides comprehensive source of chemical release (air, water, and ground) information from a large population of facilities. The data are useful for a crude estimate of toxic releases from industry. Latitude and longitude coordinates for chemical release points are available. Confidential data limited to competitive information for a small number of facilities.

Weaknesses: Facilities report estimated data to TRI, and the program does not mandate that they monitor their releases. TRI does not cover all toxic chemicals or all industry sectors. Facilities that do not meet the TRI reporting threshold levels are not required to report. The TRI does not account for toxic emissions from cars and trucks, nor from the majority of sources of releases of pesticides, volatile organic compounds, fertilizers or from many other non-industrial sources. Release of official data is lagged by 30 months, up to 18 months after year-end reporting period. The system allows retroactive updates to data back to 1987. A subset of the information may be duplicated in other Cal/EPA systems.

For example, for Imperial County from the TRI in 2005, there were a reported 26,220 pounds of ammonia, 10,000 pounds of cyanide, 2012 pounds of lead compounds (fugitive air emissions); 259,285 pounds of ammonia (point source air emissions (Spreckels Sugar Company, Brawley)); 16,636 pounds of nitrate compounds in land treatments; and a total of 76,306 pounds of compounds used in other land disposal**.**

Web Source: http://www.epa.gov/tri/topics.htm

"Brownfield" Sites/EnviroStor

Description: EnviroStor (CA Department of Toxic Substances - DTSC) shows properties in California where hazardous substances were released, or where the potential for a release existed. This mapping tool shows federal superfund sites, school cleanup and evaluation sites, leaking underground fuel tank sites (LUFT), and spills, leaks, investigation, and clean-up (SLIC) sites (LUFT and SLIC data from GeoTracker, State Water Resources Control Board). In Figure 4, we can see several on-going school investigation sites in the Imperial Valley. The one that is highlighted, Remington Junior High School, is on 19 acres of former agriculture land which was used for row crops, which may be contaminated with dioxin, arsenic, chlordane, DDE, and Toxaphene. Several LUFT sites are also shown. Clicking on the map in EnviroStor yields more identifying information.

Strengths: Display spatial and attribute data on leaking underground fuel tank sites and superfund sites undergoing remediation.

Weaknesses: Does not include all contaminated sites in California, i.e., sites not falling within the jurisdiction of DTSC.

Web source: http://www.envirostor.dtsc.ca.gov/public/

5. Water Pollution

GeoTracker

The State Water Resources Control Board operates GeoTracker, the Internet interface to the Geographic Environmental Information Management System (GEIMS), a data warehouse which tracks regulatory data about underground fuel tanks (LUFT), fuel pipelines, and public drinking water supplies. GEIMS was created after extensive review of multiple environmental databases. GEIMS can store extensive data related to LUFT sites, or any other contaminant release. In addition, GEIMS is used to store and display information from various agencies including water quality information, water use information, and infrastructure data needed to assess both water supplies and contaminant sites. The database also includes information on spill sites and tracks movement of contaminant plumes. The location and water quality at public drinking water wells comes from the Department of Public Health. There are approximately 40,000 closed and open leaking underground tanks in the database; with approximately 15,000 of open where continuous monitoring is done. Monitoring wells are drilled around some leaks and water samples are taken quarterly (or at other time frames) and sent to the laboratory for analysis of contamination.

Strengths: GeoTracker gives users the ability to assess potential threats to their drinking water sources. GEIMS was designed to accept electronic submissions of analytical chemistry (LLNL report, July 1999). Location information about each monitoring site is available. The readily accessible database results in less duplication of effort and improved communication between stakeholders.

Weaknesses: Even though information on each monitoring site is available, some of the wells and LUFTs may not be assigned latitude and longitude correctly. It is difficult to assign level of exposure to an individual due to lack of information on water distribution to residences.

Web source: http://www.geotracker.swrcb.ca.gov/

Figure 4: EnviroStor, Department of Toxic Substances Control, California EPA

6. Pesticides

Description: California's agricultural pesticide use reporting is considered the most comprehensive system in the world and has been used in several research studies by the Department of Health Services and other researchers. Since 1990, all agricultural pesticide applicators are required by law to report the poundage and type of application to the township, range, and section (approx. one square mile) to the County Agricultural Commissioner who in turn reports to the Department of Pesticide Regulation. Currently, plans are underway to evaluate whether reporting to a field level could be done. California has a broad legal definition of "agricultural use," so the reporting requirements include pesticide applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. The primary exceptions to the full use reporting requirements are home and garden use and most industrial and institutional uses. However, structural pest control operators, professional gardeners, and other nonagricultural pest control operators have to report to PUR. Among other information, the database contains time, date, month, and year of application, operator ID and permit number, applicator name and address, commodity/crop treated, amount planted and amount treated, pesticide product name and manufacturer, and amount of product applied. The data are used to provide a more realistic estimate of dietary risk as well as potential exposure and risk to workers.

Strengths: Data are collected and updated monthly. About 15 characteristics of each pesticide application are collected. DPR estimates that about 90% of actual use is reported. DPR is in the process of digitizing fields to capture the specific location for pesticide application using geographic coding. Confidential data limited to competitive information.

Weaknesses: Spatial resolution is only to the square mile; it is unknown within the square mile where the actual application occurred. There is limited or no information on non-agricultural use. Current backlog is approximately 7 months for event data entry. Release of official data is in October for previous fiscal year, i.e. a 16 month lag (summary data available in July).

Web Source: http://www.cdpr.ca.gov/docs/pur/purovrvw/ovr52000.pdf

B) Health Data

1. Border Migrant Deaths

Description: Border migrant deaths occur in response to tightening conditions of the U.S. Border Patrol, but also due to the harsh environmental conditions along the border. According to the CA Rural Legal Assistance Foundation, 46 deaths occurred in the Imperial/San Diego border region in fiscal year 2004. Recently, deaths have been shifting from the San Diego area to the Imperial Valley area in California, most likely due to border control efforts. Approximately 17% of all border migrant deaths occur on the California/Baja California border.

Strengths: Monitoring border migrant deaths is an important environmental public health activity, and is a reflection of overall border migrant health.

Weaknesses: Actual deaths are extremely likely to be under-reported.

Web Source: http://www.stopgatekeeper.org/English/deaths.htm

Table 2: Migrant Deaths by Sector, Fiscal years 2000-2004

ENTIRE BORDER

Deaths by Sector
2000-2004 Fiscal Year Comparison

SECTOR	FY00	FY01	FY02	FY03	FY04*	% of Total Deaths
McAllen	40	37	30	39	35	13.1%
Laredo	47	28	15	18	17	6.4%
Del Rio	49	43	33	23	11	4.1%
Marfa	3	2	1	0	0	0.0%
El Paso	27	11	9	10	14	5.2%
Tucson	74	79	134	139	119	44.6%
Yuma	32	24	11	15	25	9.4%
El Centro	77	95	63	67	30	11.2%
San Diego	34	17	24	29	16	6.0%
Totals	383	336	320	340	267	100%

*FY04 through August 23, 2004.

Source: California Rural Legal Assistance Foundation

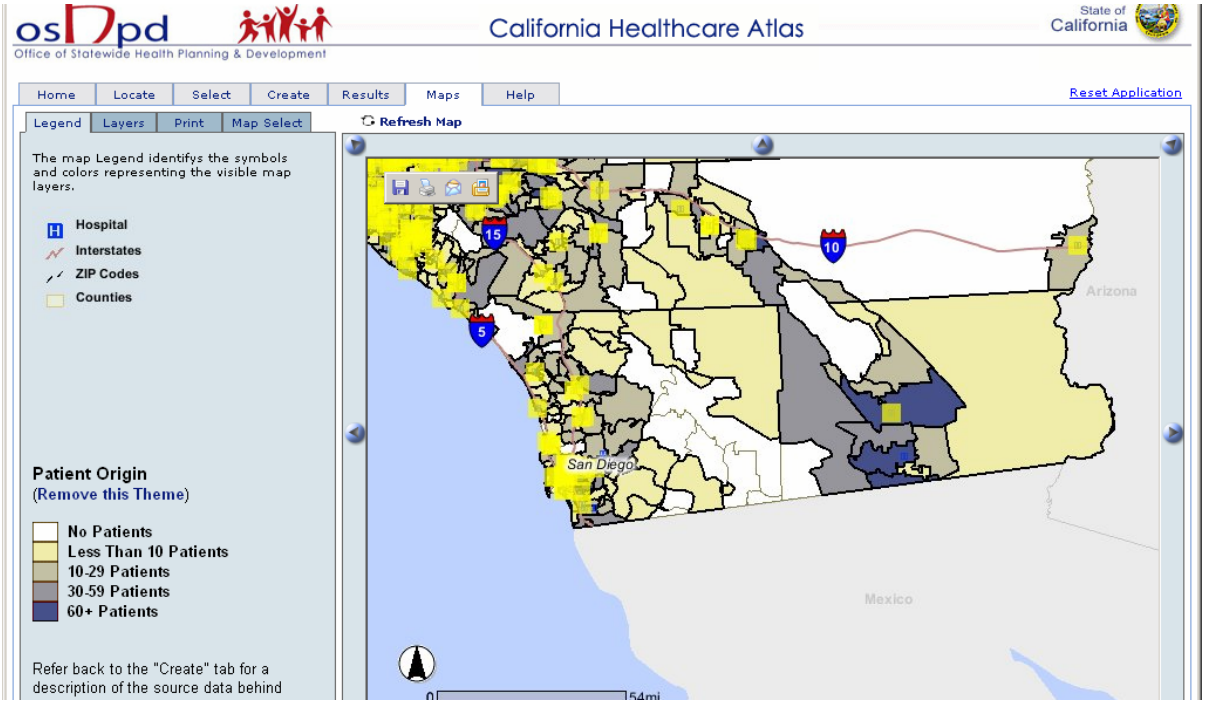
2. Asthma Hospitalizations and Emergency Room Visits

Description: The Patient Discharge Database is maintained by the California Office of Statewide Health Planning and Development (OSPHD). This dataset contains data collected from all inpatients discharged from hospitals licensed by the State of California as submitted on the Manual Abstract Reporting Form. As of January 2002, an on-line reporting system, Medical Information Reporting for California (MIRCal), was put in place. MIRCal's design improves and accelerates patient-level data collection and dissemination. OSHPD has added Emergency Department and Ambulatory Surgery data collection to the PDD. Data is collected for all California counties, but does not include federal Veterans Administration, prison, jail, or American Indian reservation hospitals. The semi-annual data is available for the first six months of the calendar year (January 1 - June 30) or the annual data is available for the calendar year (January 1 - December 31).

Strengths: OSHPD provides a comprehensive source of hospital discharge information for all inpatient admissions statewide. Data linked to the birth certificates is currently available for years 1990-2000. OSHPD's database also includes linkage to birth certificates.

Weaknesses: Patient addresses are not reported; data are only collected by ZIP code. Addresses may be available when records are abstracted from the ANSI 837 format and submitted to OSHPD. Residential history, occupational history and smoking history are also not reported. There is a six month lag for the patient discharge database, and the final updated linkage to the birth cohort data may lag up to 2 years. OHSPD has a web-based mapping function which allows the user to display counts of hospital admissions for specific diagnosis-related groups (DRGs). Figure 5 shows a screen shot of the California border counties for the number of children aged 0-17 with DRG 98 Asthma and Bronchitis, by ZIP code.

Figure 5: Number of children aged 0-17 with DRG 98 Asthma and Bronchitis, by ZIP code in Imperial and San Diego Counties.



Web Source: http://www.oshpd.cahwnet.gov/hid/MIRCal/aboutMircal/index.htm & http://www.oshpd.cahwnet.gov/hid/HID/patient/discharges/indexPD3.htm
Atlas Beta 2 release: http://www.oshpd.state.ca.us/oshpdKEY/findmaps.htm

3. Asthma/chronic disease prevalence

Description: The California Health Interview Survey (CHIS), the largest state health survey in the United States, is a random telephone-based survey. In 2001, 55,428 adults, 5801 teens, and 12,592 children participated. The survey is planned to be conducted every 2 years. The survey asks questions regarding participants' physical and mental health, including chronic conditions such as diabetes, asthma, cancer, and high blood pressure. Neurological conditions such as Alzheimer's disease might be added to the survey in the future but must compete with other proposed items. The total cost for the survey in 2001 was $11.6 million.

Strengths: CHIS collects survey data from a large sample population throughout the state and specific demographic groups, therefore providing county-level estimates (of counties with populations of 40,000 or more) of chronic disease conditions It releases survey information (unofficial data) on a daily basis. CHIS maintains information on rare diseases collected from a large survey population. It has three separate modules for adults, adolescents or children, therefore providing various health outcomes of interest at different age levels. In the future, CHIS is planning to collect address information on survey participants. CHIS may be modified to include specific health-related topics.

Weaknesses: Poor response rate (38% in 2001) raises the question of biased sample results. CHIS 2001 data did not provide street address level information. Continued funding is reliant on several sources, including The California Department of Health Services, The California Endowment, the California Children and Families Commission, the National Cancer Institute, the Centers for Disease Control and Prevention (CDC), and the Indian Health Service. The funders generally control the content of the questionnaires and competition to include questions is keen. The goal is to complete the telephone interview in 25 minutes or less, therefore content length is limited as well. There is no validation of self-reported data accuracy. CHIS maintains zip code as the only geographic identifier for survey participant. Data are a one-time snapshot of the population (collected every two years and over a several month period). CHIS is not designed to monitor trends as individual questions are unlikely to be repeated in subsequent years. Currently, it is not allowed to link CHIS data to any other database. Release of summary official data is at the end of the survey year – long lag period.

Web Source: http://www.chis.ucla.edu

4. Vital Statistics

Description: The California Center for Health Statistics maintains databases on all California live births, fetal deaths (stillbirths), and deaths (data generally available since 1960). The Birth Statistical Master File, with over 530,000 births per year, contains over 60 variables including identifying, medical, parental, demographic, and residential location information (including maternal residence address available from county-level files). The Death Statistical Master File, with over 230,000 deaths per year, contains over 50 variables from the Death Certificate. The Fetal Death Master File, with approximately 3200 records annually, contains over 60 variables from the fetal death certificate. Both the Death Statistical Master File and the Fetal Death Master file also include identifying, cause of death, demographic and residential location information. Vital statistics records are managed in the Automated Vital Statistics System (AVSS).

Strengths: Vital Statistics data files offer statewide coverage of all live births, fetal deaths, and deaths. Partial occupational history is available: decedent's usual occupation, kind of business and years in this occupation are recorded on the death certificate; maternal and paternal usual occupation and type of industry are recorded on the birth certificate. AVSS maintains birth certificate information from hospitals, birthing centers and other sources. Data from hospitals or counties is collected on a daily basis. Geographic resolution is at the individual address level.

Weaknesses: Occupational information may not be accurate. Cigarette smoking and pregnancy and birth complications are not reliably collected on the birth certificate. Amended records are not updated in AVSS. Data prior to 1990 are less robust and reliable. Official data released 12 – 18 months after events are recorded and updated in the statistical master file. Death records may take from weeks to years to complete (e.g., cases may remain open during coroner investigations). In addition, vital records may include incorrect personal and demographic data for individuals who do not want to be located or are transient.

Web Source: http://www.avss.ucsb.edu/avsshome.htm &
http://www.dhs.ca.gov/hisp/chs/OHIR/vssdata/tables.htm

5. Pesticide Illness

Description: Mandatory reporting of pesticide illnesses has been the requirement of the pesticide safety program at DPR since 1971. California physicians are required to report to their local health officer any illness which is suspected to be related to pesticide exposure within 24 hours of examining the patient. The health officer informs the county agricultural commissioner (CAC) and also completes a pesticide illness report (PIR), copies of which are distributed to the CA EPA Office of Environmental Health Hazard Assessment, to the Department of Industrial Relations (DIR), and to DPR. Since doctors do not always properly report pesticide cases, DPR's Worker Health and Safety Branch also reviews Doctors' First Reports of Occupational Illness and Injury (DFROII), which California's Labor Code requires workers' compensation claims payers to forward to DIR. Over the past several years, DPR has worked with the California Poison Control System to assist in identifying additional potential pesticide illnesses.

The SENSOR Pesticide Illness Database (PID), maintained by the Occupational Health Branch of the Department of Health Services is a separate database that collects information from DFROII and a large HMO in Northern California. The main difference between the DHS-PID and DPR-PISP is the selection criteria and classification of pesticide illnesses. Among data included in both databases are medical, demographic, residential location, occupational, and exposure information.

Strengths: Surveillance is statewide. Data are collected and updated weekly. Surveillance data is available since 1970's. The DPR-PISP continues to collect data using a revised and enhanced computer program that debuted in 1998. The new program provided the opportunity to increase the amount of data collected and to organize it more logically. In typical years, DFROII review identifies two-thirds to three-quarters of the incidents investigated. DHS-PID maintains medical information from providers as well as self-reported information. DHS-PID releases unofficial data 6 – 8 months after doctor's visit.

Weaknesses: Reporting is likely to be incomplete. Physicians often do not report or delay reporting potential pesticide illnesses. For example, in 1997 only about 30% of physicians reported cases which had been detected by the PISP through the workers' compensation system. Other sources of underreporting include lack of access to health care by workers, not seeking care due to fear of reprisal on the job, under-recognition of the conditions by health care providers, and lack of reporting by insurers to the State. The reporting systems are biased toward acute effects of pesticide exposures rather than chronic effects. Exposures at home may not come to either DPR-Pip's or DHS-Pad's attention. Data in PIR is often incomplete. All CA counties have disparate systems of forwarding Piers to DPR. Both systems maintain data limited to occupational reports of pesticide illness. Reports of an incident with multiple workers may not include information on specific individuals.

Web Source: http://www.cdpr.ca.gov/docs/whs/pisp.htm & http://www.dhs.ca.gov/ohb/OH

6. Cancer

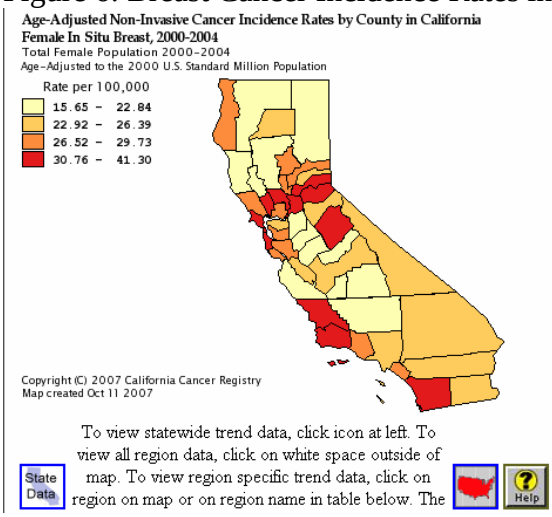
Description: The California Cancer Registry (CCR) is California's statewide population-based cancer surveillance system. It was established in 1985 by a legislative mandate. The CCR collects information about all cancers diagnosed in California (except basal and squalors cell carcinoma of the skin and carcinoma in situ of the cervix). It is now recognized as one of the leading cancer registries in the world. The CCR is a collaborative effort involving the CDHS, ten regional registries, hospitals, cancer researchers throughout the nation and the Public Health Institute. To date, the CCR has collected detailed information on over 1.3 million cases of cancer, with over 121,000 new cases added annually. The database includes information on demographics, cancer type, and extent of disease at diagnosis, treatment, and survival.

Strengths: The CCR is population-based, covers the whole state, and case reporting is considered 100% complete, according to the North American Association of Central Cancer Registries. Approximately 94% of cases in the registry are microscopically confirmed, while 1.2% of cases are based on information from the death certificate. The CCR can be linked to the CA birth certificates to obtain residence information at the time of birth to explore prenatal risk factors for cancer. CCR provides comprehensive source of single and multiple cancer diagnoses data. Data is submitted from hospitals within 6 months of admission.

Weaknesses: There is an approximate 13-20 month lag time between the time of diagnosis and the time when the data are considered at least 95% complete in the CCR. Occupational data is collected, but the quality of the information is poor. The occupation is that of the time of hospital admission or death (usually “retired” or “volunteer.”) No occupational history, no information on the length of residence at the diagnosis address, no residence history, and no smoking history are recorded for cancer cases.

The CA Cancer Registry has an interactive web-based mapping tool which allows one to display age-adjusted incidence rates of specific cancers by county. Figure 6 shows rates of in-situ breast cancer for California for 2000-2004.

Figure 6: Breast Cancer Incidence Rates in California, 2000-2004



Web Source: http://www.ccrcal.org
Cancer incidence mapping tool: http://www.cancer-rates.info/ca/

7. Birth Defects

Description: The California Birth Defects Monitoring Program is considered one of the leading surveillance systems worldwide, with data collected on over 3.5 million births. Established in 1982, the registry was granted legislative authority to confidentially access medical records hospitals, genetics clinics and labs, and link cases with vital statistics. It collects data on medical and demographic characteristics of infants with serious birth defects (live births and fetal deaths): structural birth defects such as missing limbs and malformed organs; chromosome abnormalities like Down syndrome; and birth defects patterns such as fetal alcohol syndrome. First only covering five counties around the San Francisco Bay, the registry expanded to the whole state in 1990. Starting with 1999 births, monitoring has focused on 31 groups of major birth defects, to mirror what is collected by the Centers for Disease Control's National Birth Defects Prevention Study (which California participates in). Currently, the program's registry database makes it unnecessary to monitor all births and all conditions statewide. Instead, data is gathered on a core group of conditions in a representative sample of births in 13 counties (Fresno, Kern, Kings, Los Angeles, Madera, Merced, Orange, San Diego, San Francisco, San Joaquin, Santa Clara, Stanislaus and Tulare). Collection and analysis procedures have been enhanced to improve data quality. The program monitors approximately 56,000 births per year and conducts multiple epidemiological studies (over 225 findings have been published).

Strengths: The program does not rely on passive reporting, instead trained abstractors collect information from medical records at hospitals, cytogenesis laboratories and other facilities. All addresses listed in a chart are abstracted. Subjects selected for epidemiological case-control or cohort studies are further interviewed to collect more information. In the event of

environmental incidents or concerns, the program has the statutory authority to conduct active surveillance anywhere in the state when warranted. Unofficial data is released at time of collection (every 6 months).

Weaknesses: Even though subject addresses which are listed in the medical chart are abstracted, not all participants are interviewed; therefore, a complete residential history is not available. Maternal smoking and occupational history is not available. Current registry is not state-wide, although included counties are thought to be demographically similar to the state as a whole and whose birth defects rates and trends have been reflective of those throughout California. Currently, updated data is available within 18 months of the close of the birth year, as opposed to up to 36 months in the past.

Web Source: http://www.cbdmp.org/index.htm

c) Exposure Databases

1. Childhood Lead Poisoning

Description: The California Childhood Lead Poisoning Prevention Branch receives information on children with elevated blood lead levels and stores these data in its Response and Surveillance System for Childhood Lead Exposure (RASSCLE) database. Until recently, regulations only required laboratories to report blood lead levels of 25 ug/dL or higher, although the CDC currently described the level of concern as 10 ug/dL. As of January 2003, laboratories must report all blood lead levels; and as of January of 2005 these report must be done electronically. This database is both a surveillance and case management system, containing thorough demographic, exposure, and health care utilization data. Database also contains information from follow-up investigation of exposed child if one was conducted.

Strengths: Home address and other demographic data are available. In 2003, RASSCLE began collection of results for all blood levels, not just those exceeding a threshold. Future plans include geographic coding with implementation of RASSCLE II. The system maintains data submitted within one month of test (daily for levels that exceed threshold), and official data are available within the following month, i.e. 2 month lag.

Weaknesses: No standardized reporting scheme is used, so that varying levels of lead/lab (some report only greater than 10ug/dl) are reported. Records received from laboratories may have limited information, as a result of not receiving the information from the referring physician. Updates to County systems may not be updated in State-level system.

Web Source: http://www.dhs.ca.gov/childlead/

III Environmental Health Indicators at the Border

The Pan-America Health Organization, Mexico Border Field Office, has taken the lead on developing environmental health indicators at the border (see

http://www.fep.paho.org/english/env/indicators.htm). We therefore follow their structure as outlined from their format generated from their regional workshops to assess indicators (last proceedings available: "Environmental Health Indicators for the United States - México Border. Tijuana B.C. Regional Workshop August 11-13, 2003. Final Report"). Here we focus on indicators where data is actually available: on air, pesticides, water, diarroheal illness, hazardous waste, and food-borne disease.

Air:

Environmental Air Concentrations of Contaminants

This information is available from the ADAM and CHAPIS systems (see above).

Pesticides:

Type and volume of pesticides generated in border area.

This information is available down to the square mile in Imperial and San Diego counties and is incorporated into our border GIS (see Section IV). This information is currently not available in Mexico (see Inventory of Agricultural Pesticides Used In The United States - Mexico Border Region. Final Report. PAHO. April 2005)

Water:

Percentage of population with drinking water attaining the quality standards of their country

Ground-water quality reports are generated by Ground-Water Ambient Monitoring Assessment (GAMA) reports by the State Water Regional Control Board. The San Diego area was the first area to be covered by GAMA (Michael T. Wright, Kenneth Belitz, and Carmen A. Burton. California GAMA Program: Ground-Water Quality Data in the San Diego Drainages Hydrogeologic Province, California, 2004). Public water supply wells were tested for volatile organic compounds (VOCs), pesticides, and other water quality indicators. Location, release, water quality, and water level data for Leaking UST sites are available through Geotracker, as mentioned above. A PAHO survey report (A Survey of Databases Covering Specific Water-borne Diseases and Water Contaminants in the US-Mexico Border Region; Summary Report Submitted to the Pan American Health Organization;17 October 2005;Eric C. Jones; Durham, NC) details the lack of information on water contaminants in Mexico.

Mortality rate due to diarroheal illness in children

These data are available only at the county and municipio level. Bi-national Rates of intestinal infectious disease are available in the "Mortality Profiles of the Sister Communities on the United States - México Border," published by the Pan America Health Organization – Border Field Office. Figure 7 and Table 3 show the most current data available.

Figure 7: Rate of intestinal infectious disease (per 100,000), 1995-1997, U.S./Mexico Border Areas.

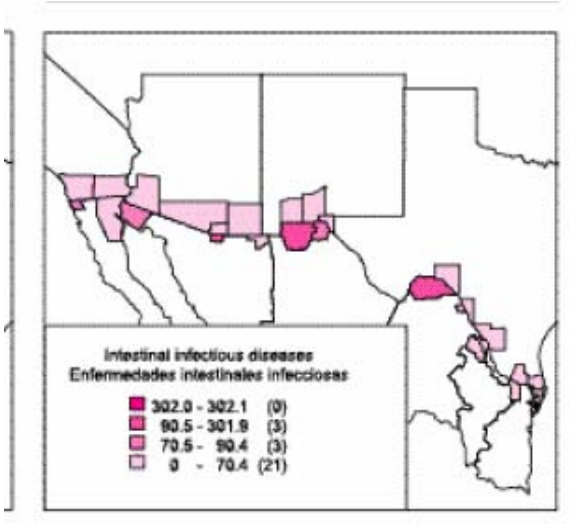


Table 3: Bi-national Data on Rates of Intestinal Infectious Disease by Age, 1995-1997

Enfermedades infecciosas intestinales(CIE:001-009)

Intestinal infectious diseases — Ambos sexos / Both sexes

Defunciones acumuladas y tasas por 100,000 habitantes, por edad y sexo en la región fronteriza, 1995-1997
Cumulative deaths and rates per 100,000 population, by age and sex in the border region, 1995-1997

País /Estado/Área	Total		< 1		1-4		5-14		15-24		25-44		45-64		65+	
Country/State/Area	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate	No.	Tasa Rate
Estados Unidos Mexicanos	25370	9.0	9034	110.8	3764	13.9	814	1.2	608	1.0	1491	1.9	2237	7.0	7345	59.2
United States	2867	0.4	620	5.3	43	0.1	19	0.0	12	0.0	109	0.0	216	0.1	1848	1.8
Estados Unidos Mexicanos	519	4.0	266	78.2	32	2.5	5	0.2	7	0.2	16	0.4	43	3.0	148	29.0
United States	65	0.4	11	3.3	2	0.2	1	0.0	0	0.0	4	0.1	4	0.1	43	2.2
BAJA CALIFORNIA	349	5.4	204	124.3	43	7.5	4	0.3	3	0.2	13	0.6	18	2.5	61	25.2
CALIFORNIA	359	0.4	66	4.1	4	0.1	6	0.0	3	0.0	15	0.0	35	0.2	230	2.2
Baja California/California	232	1.7	112	41.4	11	1.0	3	0.1	0	0.0	12	0.3	17	0.8	77	6.5
Tijuana/SanDiego	159	1.4	77	36.1	5	0.6	2	0.1	0	0.0	10	0.3	8	0.5	57	5.5
Tijuana	114	3.8	71	89.7	5	1.6	1	0.2	0	0.0	7	0.8	6	1.9	24	21.6
San Diego	45	0.6	6	4.5	0	0.0	1	0.1	0	0.0	3	0.1	2	0.1	33	3.5
Mexicali/Imperial	73	2.9	35	61.0	6	2.6	1	0.2	0	0.0	2	0.3	9	2.8	20	14.5
Mexicali	73	3.5	35	70.5	6	3.1	1	0.2	0	0.0	2	0.3	9	3.5	20	20.9
Imperial	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0

Source for Figure 7 and Table 3: Mortality Profiles of the Sister Communities on the United States - México Border," Pan America Health Organization –Border Field Office. 2000

Hazardous Wastes

The tools EnviroTracker and GeoTracker are the best sources for Hazardous Waste information (see above).

Food-borne Disease Outbreaks

The Division of Communicable Disease, California Department of Public Health, maintains surveillance of food-borne disease outbreaks in the border counties of California. In January, 2007, for example, there were 3 cases of food-borne disease in Imperial County, and 257 (three outbreaks) cases in San Diego County.

Web source: http://www.dhs.ca.gov/ps/dcdc/html/cdtables.htm

IV GIS mapping tool and database warehouse

Architecture/Technology

The Border GIS mapping tool and database warehouse were built upon several architectural features: distributed map servers, heavy lifting by both client and server, and open standards for web mapping. On the server side, we utilized the custom-developed Dynamic Map Service Integration Tool (DyMSIT) from the California Environmental Health Tracking Program (CEHTP). This allows for client-specified and real-time consumption, overlay, and output of multiple distributed Web Map Service (WMS) and ArcIMS Map Service endpoints. The client interface to DyMSIT follows the WMS-standard and supports the following requests: GetMap, GetFeatureInfo, and GetLegendGraphic. DyMSIT also supports server-side database caching of image output, and transparency/opacity between/among input services/layers. DyMSIT is a Java Servlet. Map services from the USGS US-Mexico Border Environmental Health Initiative site are called at runtime as are endpoints at the CEHTP gateway.

On the client side, the free Google Maps Application Program Interface (API) was used in developing a custom interactive browser-based mapping platform. Google Maps API was selected because of its support for detailed base map and satellite imagery layers, easy/fluid client experience, the ability to easily incorporate DyMSIT content dynamically, and the ability to add additional user interface functions. We harnessed the Google Web Toolkit (GWT) for additional user interface functions, presentation, and remote procedure calls to external web-based query systems. GWT is an asynchronous Javascript and XML (AJAX) application development framework. All functions performed by the Border GIS mapping page occur without page reloads or popup browser windows. Though popup objects are utilized throughout the site, browser popup blockers are avoided. The resulting Javascript library and presentation page were added to the EHIB content management system, accessible at http://www.ehib.org/project.jsp?project_key=GISB01.

Content

We decided to concentrate on the following areas to incorporate into our GIS border environmental health warehouse (http://www.ehib.org/project.jsp?project_key=GISB01) due to the data format, availability, and usability in a web-based mapping tool, which was not redundant with efforts described above:

(1) Pesticide Use; (2) Traffic Data; (3) Local preterm delivery rate estimation; (4) Ozone and PM_{10} data at bi-national air monitors; (5) Bi-national land use; and (6) Point locations of schools. More detailed description of these databases can be found above in Section II "Inventory/Assessment of Health, Hazard, and Exposure databases." Detailed metadata are incorporated into the website for bi-national cities, bi-national air monitors, traffic, preterm birth, and bi-national land use. Metadata includes identification, data quality, spatial data organization and reference, entity and attribute, distribution, and metadata reference information.

Agricultural Pesticide Use Data from the California Department of Pesticide Regulation Data from 1995 to 2005 is loaded into the system. Data can be grouped as all chemical formulations, cholinesterase inhibitors, EPA Hazardous Air Pollutants (HAPs) and CA Toxic Air Contaminants (TACs), EPA known, possible, and probable carcinogens, developmental and reproductive toxicants, and endocrine disruptors. Time series tables and charts can be displayed for selected pesticides at the state, county, township and section level.

Traffic data from the California Department of Transportation. A layer of functionally-classified roadway segments has been compiled for Imperial and San Diego counties and linked to average annual daily traffic statistics current to 2004. Road segments are clickable to display annual average traffic values.

Local preterm delivery rate estimation. 2001-2003 locally smoothed rates of preterm birth are displayed on the map. Data are from the California Center for Health Statistics. Data have been smoothed using non-parametric Generalized Additive Models with a loess smoother.

Ozone and PM_{10} data. Locations of bi-national air monitors and data on ozone and PM_{10} were obtained from the California Air Resources Board. Time-trend data varies by pollutant and site by clicking on air monitors.

Bi-national land use. The U.S./Mexico Border Environmental Health Initiative Binational Land Cover Dataset for the U.S. Geological Survey was used as a data layer. Eight classes of land use are displayed and defined in the legend.

Schools. Elementary, middle/junior high, and high school names and locations were obtained from the CA Department of Education. Schools are clickable for names and addresses.

Functionality

GWT assists in providing the user interface functions for laying out the map window, layer list, legend, and pop-up content. The layer list is populated from a meta-repository describing the map services/layers that CEHTP maintains. Each layer item can be checked on or off in terms of visibility for rendering image output on the map, or in terms of clickability for enabling WMS GetFeatureInfo (i.e. Identify) requests. If FGDC standard metadata have been identified for a service/layer, then the layer name is made linkable and, upon clicking, a window pops up displaying the metadata and is formatted in the FGDC Classic style. Pop-ups are provided for some layers where additional custom rendering options have been built. For example, the pesticides layer is derived from the CEHTP-developed Agricultural Pesticides WMS and has many display options for producing chloropleth maps by Public Land Survey (sections or townships depending on zoom level). For pesticides, we provide the ability to select a reporting year (1991-2005), 6 commonly requested pesticide groupings (e.g. All pesticides, Cholinesterase Inhibitors, Endocrine Disruptors, etc.), and an opacity slider.

Individual layers can be rearranged by clicking a handle on the right side of the layer item and dragging-and-dropping the layer item in a new position. The map view and layers/legend list can be maximized over the rest of the EHIB navigation by clicking the maximize icon. There is an icon for minimizing the map view back so that EHIB navigation displays again. An opacity slider is provided for all of the Border GIS layers over the Google layers.

The Google Maps API provides customary internet mapping functions that are increasingly recognized by the lay public: drag- and double-click pan/zooming, toggling between Google's Map, Satellite, and Hybrid layers, and an information window that pops-up over markers placed on top of the map. Placing a marker on the map or dragging an existing marker to a new location when Border GIS layers are visible and clickable results in a GetFeatureInfo request to DyMSIT and all of the services/layers managed by DyMSIT. The GetFeatureInfo XML results are formatted and placed in the Google Maps information window pop-up. If there are multiple results in a single layer, then record navigation options (i.e. first, previous, next, last) are provided. If the GetFeatureInfo response includes results from more than one layer, then the information window has one tab for each layer.

GetFeatureInfo results for Bi-National Air Monitors and Pesticides include custom time series tables and charts that pop-up over the Google information window. Time series content for the air monitors is provided by dynamically linking to the Aerometric Data Analysis and Management web-based query system that is hosted by California Air Resources Board. Tables and line graphs of annual time series indicators for ozone and PM10 are presented. Annual time series tables and bar charts for pesticides data is accomplished by making remote procedure calls to web services developed by CEHTP. Indicators are presented for cascading geographies (sections, townships, counties, state) and 3 metrics (summed pounds, treated acres, and pounds/acre).