



**Promoting Sustainability Science  
Through Education and Regional  
Ecology**

**UC San Diego  
Superfund Basic  
Research Program**

**Outreach Core  
Newsletter No. 1**

**December 2001**

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**Introduction: SBRP Outreach Aims**

UC San Diego's Outreach Core links SBRP-generated knowledge to the needs of community-based partners in education, industry, and regional planning. The education partnerships target environmental science curriculum development and teacher training in two of San Diego's disadvantaged high schools. Faculty mentors in the Outreach Core and SBRP science laboratories provide Student Interns with hands-on guidance in experimental research on waterborne toxicants. Outreach with industrial groups and public sector agencies is geared to improving regional water quality monitoring, management, and reporting. The collaborative aim of the joint university-industry-government partnerships is to develop planning and decision support tools capable of integrating biological, geophysical, technical and social systems research. The National Research Council (1999) characterizes this type of integrative activity as “sustainability science.” To promote sustainability science the NRC calls attention to three priority tasks—each of which are taken up by UC San Diego’s SBRP Outreach Core:

1. Develop a research framework for the science of sustainable development that integrates global and local perspectives to shape a place-based understanding of the interactions between environment and society.
2. Initiate focused research programs on a small set of understudied questions that are central to a deeper understanding of those interactions.
3. Promote better utilization of existing tools and processes for linking knowledge to action in pursuit of a sustainability transition. (NRC 1999: 279)

To develop a research framework for sustainability science, the Outreach team is establishing a “Regional Workbench”(RWB) program <<http://regionalworkbench.org>>. The RWB is a Web-based resource for education, training and research. The interdisciplinary construction of this workbench hinges on a small set of focused research projects drawing together theoretical insight from natural, physical, social and technical domains (see article below on the RWB and Regional Ecology). As a part of this effort, the Outreach team is building a federated Geographic Information System (GIS) useful for linking Superfund-related basic science to public health issues and integrated risk assessment. Right now the

geographic focus is on the San Diego-Tijuana cross-border region. Lessons from the San Diego-Tijuana case will be shared with all 14 twin cities spanning the US-Mexico border. The long-term objective is to build knowledge-based tools and integrated information systems that can be used by scientists, planners and decision-makers in varied local and regional settings as well as national and international contexts. Visualization, on-line interactive mapping, knowledge-based "topic map" construction, and 3D model building are key aspects of this work (see articles below).



## **Promoting Sustainability Science through Education and Regional Ecology: A Workbench Approach**

The widely cited Brundtland Report defines sustainable development as development that meets the needs of society's current generation without compromising the ability of future generations to meet their own needs (WCED 1987). This concept of sustainability has entered the mainstream.<sup>1</sup> The 1992 Rio Conference on Environment and Development has produced a widely disseminated set of principles and action programs, including *Agenda 21*, for achieving sustainable development over the next two generations.<sup>2</sup> The major concern is to meet fundamental human needs while preserving the earth's life-support systems. In the case of the U.S.-Mexico border region, there has been an impressive growth of new institutions dedicated to environmental management and principles of sustainability (notably, Border XXI, CEC, BECC and NADBANK).<sup>3</sup> Unfortunately, a recent study completed by the UN Environment Program comes to the conclusion that sustainability initiatives have for the most part been disappointing (UNEP 1999). One can point to "best practices," but outcomes are small, few and slow. There is no consensus on what exactly needs to be sustained, how and by who. And other issues compete for the attention of decision-makers. Even when strong political will exists to advance sustainability goals, the science, knowledge and know-how to make progress is often lacking.

The Council of Scientific Society Presidents argues that sustainable development depends critically on increasing interdisciplinary education and scientific research: "Sustainable development depends on sound basic and applied research, the development of strong linkages between science, policy and action, and collaboration by NGOs, academia, the private sector, and government" <[www.science-presidents.org](http://www.science-presidents.org)>. Yet, as Kates, et al., point out in a recent issue of *Science Magazine*, the late-1980s and early-1990s was a period during which "much of the science and technology community became increasingly estranged from the preponderantly societal and political processes that were shaping the sustainable development agenda." In light of sustainability's ambiguity, yet promise, the Policy Division of the National Research Council (NRC) convened a Board on Sustainable Development, chaired by Edward Frieman of UC San Diego. The NRC challenged this working group to come up with a plan to "reinvigorate the essential strategic connections between scientific research, technological development, and societies' efforts to achieve environmentally sustainable improvements in human well-being" (1999: 2).

At the end of their deliberations over a four year period (1994-1998), the Board published a major report, titled, *Our Common Journey: A Transition Toward Sustainability*. They presented it at a conference attended by 80 international academies gathered to deliberate on the topic of a transition toward sustainability.<sup>4</sup> The U.S. academies that participated include the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. The *Our Common Journey* report spells out a framework for "sustainability science." This framework requires

planning and decision support tools capable of integrating biological, geophysical, technical and social systems research (see Figure 1).

Along such lines, the NRC calls attention to the urgent need for “significant advances in basic knowledge, in the social capacity and technological capabilities to utilize it, and in the political will to turn this knowledge and know-how into action” (NRC 1999: 7).

The *Our Common Journey* report identifies the region as the most useful territorial unit for organizing sustainability initiatives: “The major threats and opportunities of the sustainability transition are not only multiple, cumulative, and interactive, but also place-based. In other words, it is in specific regions with distinctive social, and ecological attributes that the critical threats to sustainability emerge, and where a successful transition will need to be based” (National Research Council 1999: 285). In light of this rationale, authors of the NRC report call for integrating knowledge and action by way of building regional information systems:

Experience in developing such information systems shows that a regional scale approach grounded in ecosystem knowledge and cooperative and adaptive management constitutes an infrastructure for social learning—a way to lay out scientific knowledge in a form that can be accessible to non-specialists. As such these systems provide a mode of communication and negotiation that can draw opponents together for learning as well as conflict resolution, allowing learning to continue as action proceeds. Work at the regional scale shows that the way human and natural systems interact can be studied and acted upon in an integrated framework (NRC 1999: 6)

It is in the above sense—i.e., defining a regional scale approach grounded in ecosystem knowledge and cooperative and adaptive management—that the UCSD’s SBRP Outreach Core employs “regional ecology” as a conceptual framework for linking sustainability science to policy and planning. In regional ecology, the term “ecology” carries a twofold meaning. The first meaning is sociological referring to the study of the relationship and adaptation of human groups to their environment. The second meaning is biogeophysical referring to the management and conservation of habitats and ecosystem services including the consequences and control of environmental degradation.

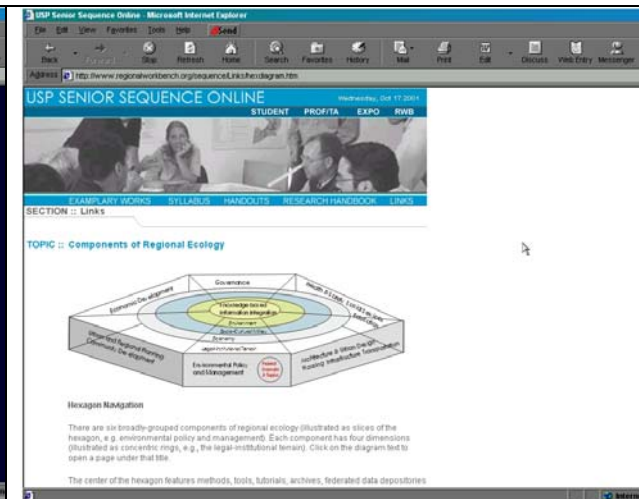
The Outreach Core’s Regional Workbench is an ongoing initiative aimed at defining regional ecology as a terrain for theory-building and practice. Three broad objectives of the Regional Workbench (RWB) include:

- Engender excellence in graduate, undergraduate, and high school research education and training, including workforce development
- Facilitate the creation, integration and sharing of data and multidisciplinary knowledge across academic divisions, including the social and natural sciences, humanities, engineering and health
- Develop a series of integrated "topic maps" for linking research to policy and action in urban and regional development with special emphasis on toxics and water quality (a "topic map" is defined here as coherent research domain with associated archives, professional and institutional contacts, data sources, data mining tools, metrics, methods and annotated guides for inquiry and action).

The Workbench approach is an excellent way to provide a gateway to well-organized information, as well as scenarios of how these resources can be used in research projects. The RWB is being developed in the spirit of several discipline-specific researcher interfaces such as the Biology Workbench (developed at NCSA by Shankar Subramanian), the Sociology Workbench (developed at SDSU by Ilya Zaslavsky - now with the San Diego Supercomputer Center), the Environment Workbench from NASA, Scientist's Workbench from Cornell, etc. The RWB will serve as a web portal for such discipline-specific workbenches, linking them with regional-scale data, and presenting students and faculty with an arsenal of research tools in the regional development context. A good workbench has the following characteristics: searching of data, computation using internal/external resources, joining of complex repositories, uploading of completed research. As it evolves, the RWB website will contain projects, searchable topic maps, data guides, tutorials, and interactive tools for conceptualizing, designing, conducting, and sharing multidisciplinary research.



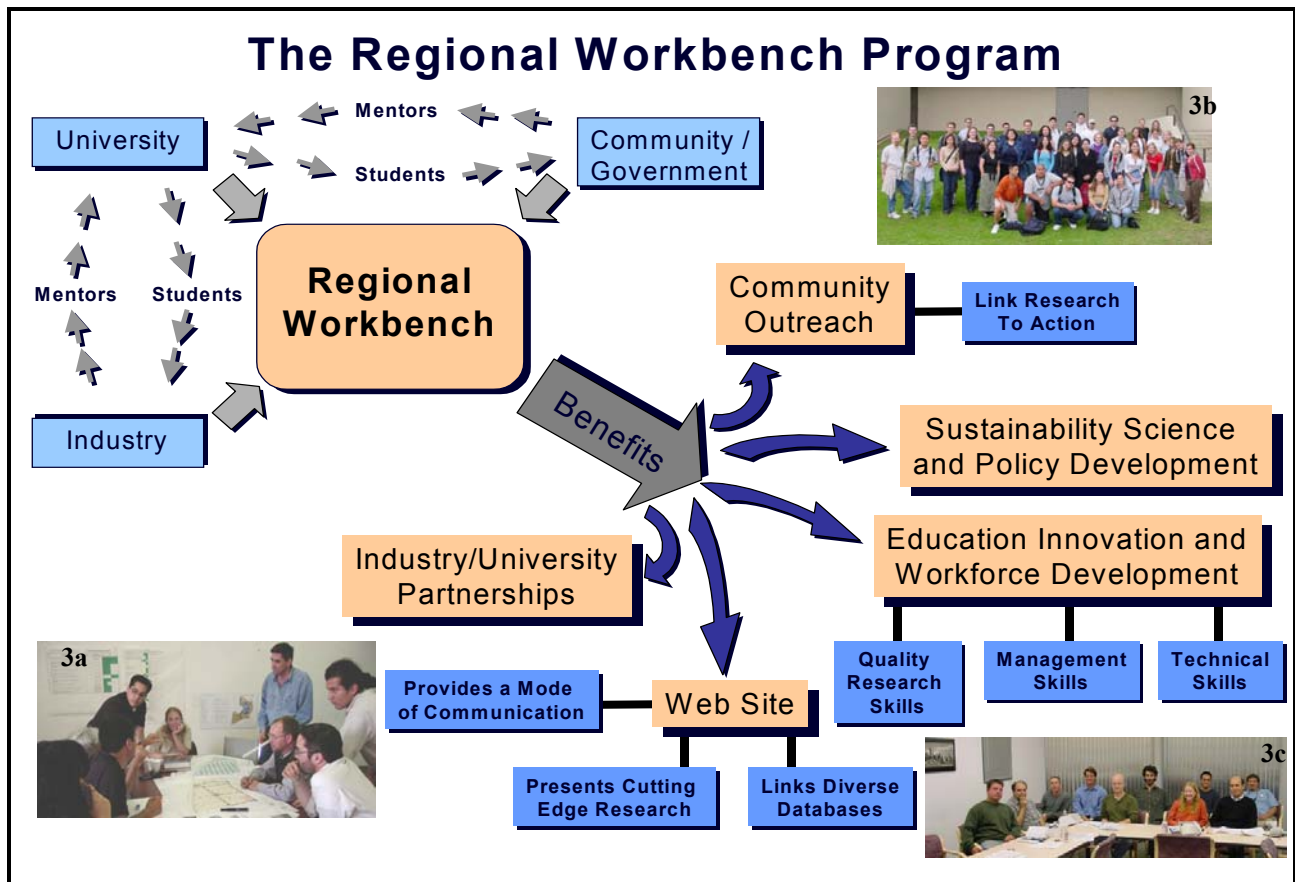
**Figure 1.** Regional Workbench home page <http://regionalworkbench.org>



**Figure 2.** The student section of the Regional Workbench showing the regional ecology navigator <http://regionalworkbench.org/sequence>

University students and faculty, together with community partners, build the RWB's web site. Students gain hands-on experience in a manner that emphasizes civic-minded workforce development as well as multidisciplinary scholarship <<http://regionalworkbench.org/sequence>>. A steady source of research interns for the building the RWB comes from UCSD's Urban Studies and Planning (USP) Program. In this way the Outreach Core is directly tied into promoting excellence in undergraduate research education. The USP *Senior Sequence* <http://regionalworkbench.org/sequence> is a required, two-course seminar on research methods and practice for upperdivision undergraduates majoring in Urban Studies and Planning. Over a six month period, each student is instructed how to design, conduct, and write-up an original senior thesis. As an integral part of the *Senior Sequence*, students do an internship in a public, private, or non-profit setting of their choice. For a sample of student work, see the San Diego Neighborhood Studies Project completed in collaboration with TELESIS, a major community-based partner of the SBRP Outreach Core <<http://www.qolsandiego.net/library.htm>>. Students in this USP sequence work as research interns for the SBRP Outreach Core, for example with the Industrial Environmental Association. These students are building the SBRP-funded Regional Workbench program illustrated in Figure 3.

An important challenge in building the Regional Workbench is the task of defining an ontology for navigating regional ecology. In the diagram of the regional ecology navigator shown above, we list six broadly-grouped components of regional ecology (illustrated as slices of the hexagon, e.g. environmental policy and management). Each component has four dimensions (illustrated as concentric rings, e.g., the legal-institutional terrain). The center of the hexagon features methods, tools, tutorials, archives, federated data depositories and other on-line resources for knowledge-based integration and sharing of data, information and wisdom. Working from the inside out, each ring surrounding the ICT core corresponds to the integrated aims of promoting sustainable development: (1) wise stewardship of ecosystems and natural capital (environment), (2) social justice and equity (socio-cultural milieu), (3) eco-efficiency in systems of production, distribution and exchange (economy), and (4) adaptable governance and political organization that supports aims 1-3 while fostering learning and innovation (legal-institutional terrain). This effort is still very much in its infancy. However there is some significant progress to report on several fronts. One project that fruitfully integrates aims in education, industry, and government outreach is the 3D model and visualization initiative, as briefly described in the next article.



**Figure 3. Regional Workbench Organization and Benefits**

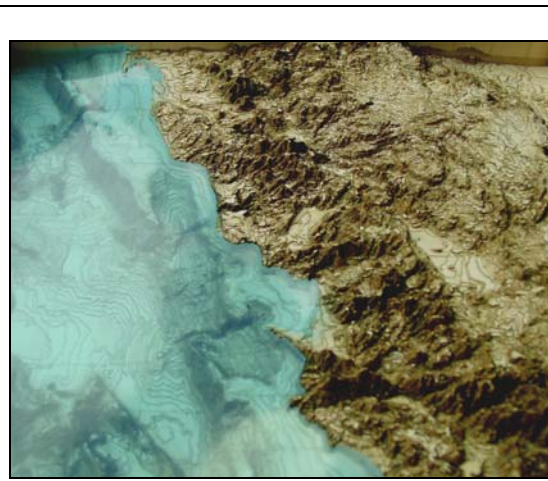
**Photos:** (3a): Meeting between members of SBRP Outreach Core and IMPLAN (Municipal Planning Institute of Tijuana Municipal de Tijuana) to discuss an environmental design and community development initiative (see 10 de Mayo article below); (3b). The USP Senior Sequence class of 2002; and (3c) A meeting of the UCSD SBRP Web development and information integration team.

### 3D Model Building and Visualization in Support of Watershed Management, Planning and Education

The 3D model shown in the photo (and underlying the cover of this newsletter as a translucent image) integrates topographical and bathymetry data, and lays an important foundation upon which to add GIS layers for coastal water quality planning and decision-support processes. The model was funded by the SBRP Outreach Core with additional support from the SBRP Training Core and UCSD's Center for Research in Educational Equity and Teaching Excellence (CREATE). The 3D model, in its solid and digital versions is the first of its kind in so far as it integrates U.S.-Mexico ocean bottom (bathymetry) data with topographical data. This has great value as a base map for research, training and outreach on all sorts of levels (e.g. integrated risk assessment, resource conservation, land use planning and coastal zone management, K-12 education, museum exhibits, and more). The solid 3-D model has a wood-like feel to it; but it is actually constructed out of hundreds of sheets of paper cut by a laser at the San Diego Supercomputer Center's Telemufacturing facility <http://tmf.sdsc.edu/>. Richard Marciano (SDSC), Steve Miller (SIO), Dru Clark (UCSD), Alejandro Hinojosa (CICESE, Mexico), Keith Pezzoli (Urban Studies and Planning), Mark Legg, among a host of others, are making this happen. Mike Bailey runs the telemufacturing facility. Examples of this work can be viewed at

<http://tmf.sdsc.edu/Examples/earth.html> . Now that the solid model is built we plan to create copies including a specialized translucent version that will enable us to rear project GIS data (maps of regional watersheds, land use, pollution hot spots, etc) onto the surface giving us a excellent visualization tool. This requires additional fund raising. There is an article about this method titled, "Rear-Projecting Virtual Data onto Physical Terrain", D. Clark, R. McKeon, R. Marciano, M. Bailey, IEEE Visualization '98, Oct. 18-23, 1998, Research Triangle Park, N.C.

We can also plan to use the 3D model in SIO's new Visualization theatre to interactively display high quality scientific data. The Panoram Theater, located in SIO's Revelle Conference Room, is designed for Groups of participants to visually immerse themselves in the subject of study. The theater projects 3D displays of data on a 22-foot curved screen (<http://www.panoramtech.com/gvr120e.htm>). Until recently, this type of facility has been available only at high level of corporate briefing centers, but the participation of Panoram Technologies in the CAL-IT<sup>2</sup> Initiative (<http://www.calit2.net/eci/visualization/>) has brought a system to UCSD.



**Figure 4.** 3D Solid Model, Southern California/Northern Baja California. The model is constructed out of hundreds of sheets of paper cut by a laser at the San Diego Supercomputer Center's Telemanufacturing facility <http://tmf.sdsc.edu/>



**Figure 5.** Panoram Theatre at the Scripps Institution of Oceanography (a presentation organized by the SBRP Outreach Core for the San Diego-based Regional Water Quality Control Board and San Diego Association of Governments, November 9, 2001)

The Superfund Outreach Core recently collaborated with colleagues from Scripps Institution of Oceanography in submitting a proposal to the University of California Marine Council (UCMC), Coastal Environmental Quality Initiative. As noted in the proposal, this work lays an important foundation for UCSD researchers and faculty in the physical and social sciences to address four key problems that hinder progress in Coastal Policy, Planning and Management, and Law.

1. Decision-making is often hindered by lack of a common framework. Scientists, engineers, planners and attorneys have diverse training, vocabulary and backgrounds.
2. Environmental issues are often spatially complex. Distributed and point sources and sinks may not be initially obvious until all data are integrated with topography, and visualized in three dimensions.
3. Data from diverse disciplines are almost always inconsistent. Conflicts in spatial resolution, coordinate systems, and raster vs. vector format inhibit effective comparisons.

4. There is no central contact person to integrate diverse data. Each investigator is familiar with his or her own field, but find it challenging to relate to geospatial data from other disciplines.

To address these problems, we propose the following four solutions:

1. Provide a common group setting for experiencing diverse data in a new state-of-the-art immersion theater for visualization at SIO.
2. Provide interactive 3D and stereo visualization of geospatial data layered onto terrain models.
3. Provide interfaces between common GIS, imagery, and geospatial software and data sources, in both commercial and public domains.
4. Provide a reliable technical point of contact for expertise in data integration and visualization. Train investigators and students in use of the Panoram facility, as well as the use of visualization and data integration tools they can use from their own desktop.<sup>5</sup>

One of the test bed applications for this initiative focuses on the Total Maximum Daily Load (TMDL) process. A TMDL is defined in two ways: (1) it is a quantitative measure specifying how much pollution a specific water body can assimilate before its designated beneficial use becomes impaired, and (2) it is a planning process for implementing state water quality standards. Section 303(d) of the federal Clean Water Act requires States, Territories and authorized Tribes to submit to the USEPA (once every two years) a list of impaired waters including the pollutant(s) causing the impairments. The Superfund Outreach Core will be working with the San Diego-based Regional Water Quality Control Board (RWQCB) in an effort to build a digitally integrated, georeferenced, user-friendly, and knowledge-based information system for improved water quality monitoring, reporting and management.



**Figure 6.** Regional Water Quality Control Board, San Diego



**Figure 7.** John Robertus (Executive Officer, RWQCB) in the file room at their new facility in San Diego. Photo taken November 5, 2001, the day the SBRP Outreach Core made a formal presentation to the RWQCB

The RWQCB is responsible for updating the San Diego Region’s list of impaired waters and steering the regions TMDL process. The number of Impaired Waters Listed in Region 9, San Diego, and Statewide is shown in Table 1.

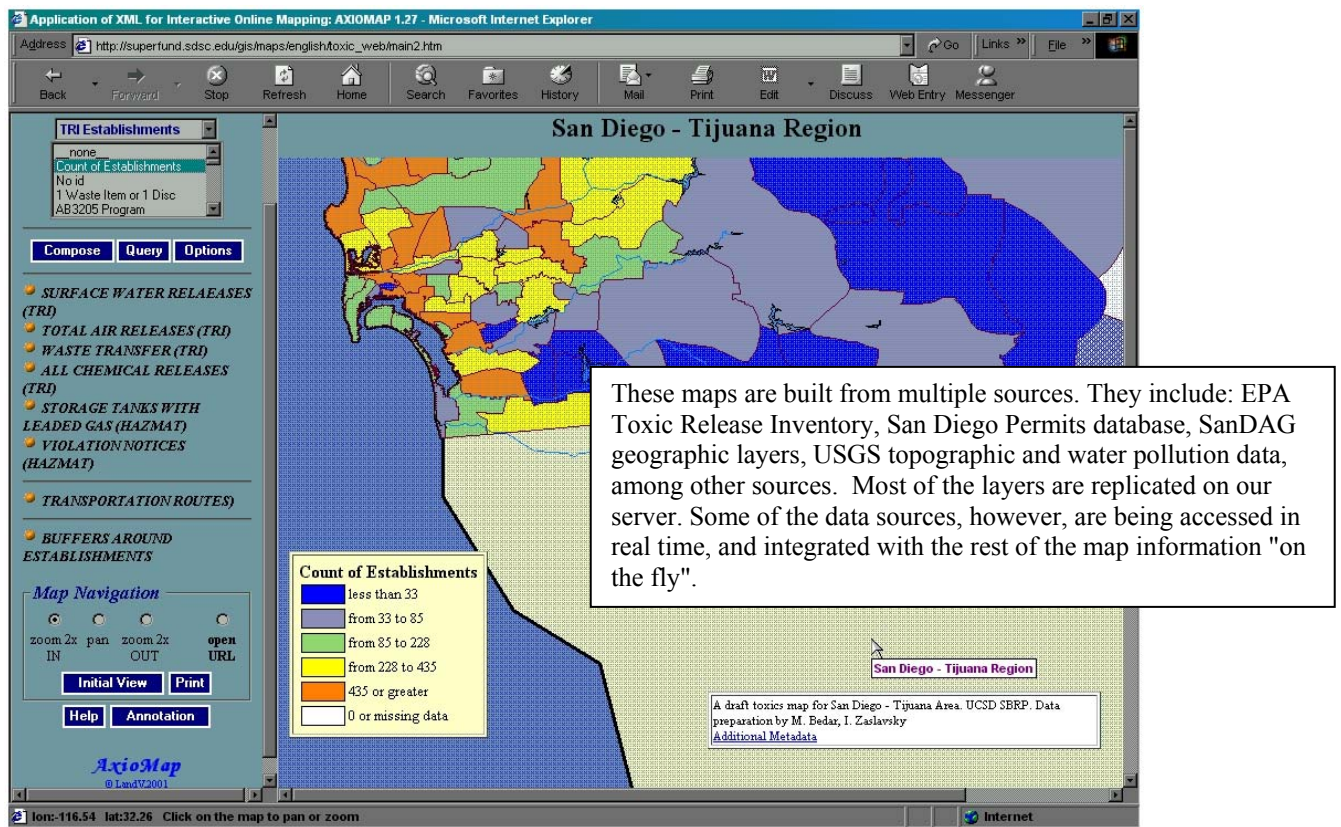
**Table 1. Impaired Waters Listed in Region 9, San Diego, and Statewide**

Year	303d Listed Waters Region 9, San Diego	303d Listed Waters Statewide
1976	2	<20
1988	8	75
1990	15	250
1998	36	509
2002	60* (# recommended for listing/ update is in progress)	na

Source: Regional Water Quality Control Board, Region 9

As outlined in the next article, the SBRP Outreach Core is placing a major emphasis on developing Web-based interactive mapping as method to assist planners, policy-makers and regulators as they confront the complexities of such things as the TMDL process, storm water permitting and, more broadly, watershed management. Our effort to federate spatial data on toxics also provides educational tools and workforce development opportunities.

## Federating Spatial Data On Toxics



**Figure 8.** SBRP Outreach Core Interactive mapping Web site

Integrating spatial information on hazardous substances with diverse industrial, demographic, environmental and health data for the San Diego-Tijuana border region is a major objective of the Outreach Core. The geographic database we are designing will facilitate research, education, training, and communication about existing and potential risks to human health. The system is intended for researchers interested in spatial extents of particular toxics, high school students and teachers in San Diego and

Tijuana, and general public, providing easy access and navigation in the world of spatial environmental data on toxics and hazardous wastes. At the same time, it serves as a testbed for new information mediation and presentation techniques being developed as part of the MIX (Mediation of Information using XML) project of the San Diego Supercomputer Center.

The Web site is being designed to enable users to explore spatial distributions of toxic substances in San Diego-Tijuana border area in several integrated ways:

- Browse [online interactive maps of toxic substances](#), overlaid on various industrial, demographic, environmental and health indicators derived from a variety of databases.
- Explore various [databases](#) that deal with toxic substances
- [Query individual databases](#) on toxic substances, or several databases at once
- [Upload](#) your own environmental data (access restricted)
- Browse various [studies](#) focused on hazardous substances in the area, and related research produced by the Superfund team.
- Read [background information](#) on toxic substances
- Read about the [technologies](#) behind this project.



**Figure 9.** IEA President, Craig Anderson, addressing participants of the annual conference (November 8-9, 2001). Keith Pezzoli, Director of the SBRP’s industry Outreach, gave a presentation at this conference titled “Linking Environmental Science to Policy: The UCSD Superfund Basic Research Program.” Sitting at the far right of the front table is the new Director of EPA Region 9, Mr. Wayne Nastri.

#### **IEA-SBRP collaboration**

With respect to TMDLs and issue of spatial data federation, the UCSD SBRP Outreach Team is collaborating with the Industrial Environment Association (IEA). Pezzoli presents at the IEA’s annual conferences. As the Director of Field Research for UCSD’s Urban Studies and Planning Program Pezzoli places undergraduate student research interns at the IEA. The SBRP Outreach Intern placed at the IEA last year (Sara Ferman) focused on the data challenges of implementing ISO 14001 Environmental Management Systems (EMSs). Ferman’s senior thesis earned honors and is now in the Urban Studies and Planning library.

#### **Web Environmental Informatics (WebEI) and SBRP Information Integration :**

<http://www.npaci.edu/enVision/v16.3/environment.html>

The San Diego Supercomputer Center’s Environmental Informatics initiative, headed by David Stockwell, is collaborating with the RWB to develop multidisciplinary data sets and tools to understand the complex dynamics of environmental change in California--and its implications for public health and economic stability. The goal of the WebEI-RWB collaborative is to conduct research that will promote the development of a distributed, interoperable, and scalable environmental information network that will enable us to build capacity for integrated regional planning.

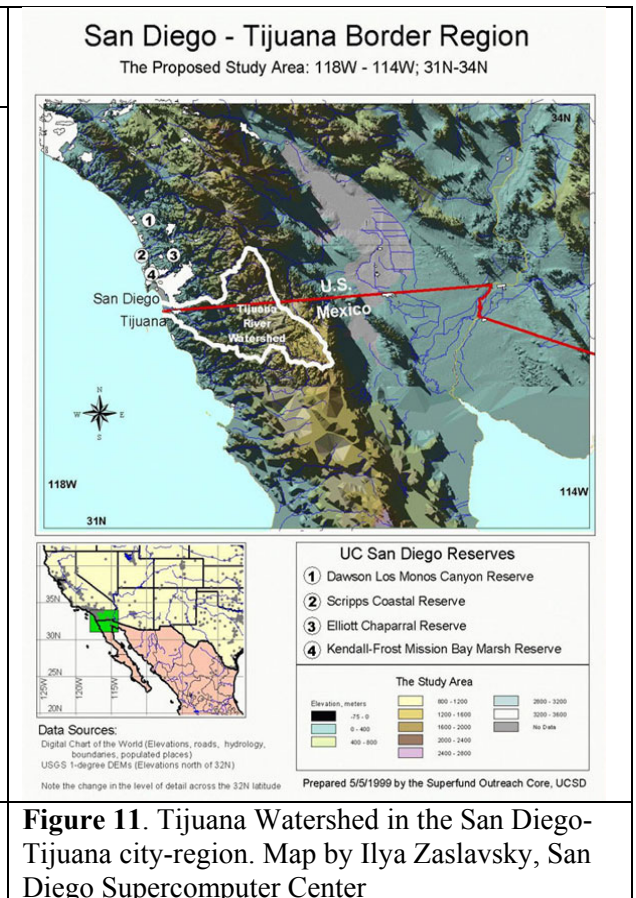
Federating data sources in a transborder city-region such as San Diego-Tijuana is complicated given differences in data collection protocols, accessibility, quality, etc. For this reason there must be a concerted effort to build genuinely collaborative ties across the border. Along these lines, UCSD's Outreach Core has a major emphasis on building knowledge networking capability in the transborder areana. (see next article).

## Promoting Collaboration in the U.S.-Mexico Border Region

There is a critical need for long term integrated planning in cities and regions. This is particularly true for large binational metropolitan areas, which need to be organized as single systems composed of communicating networks of infrastructures. Integrated scenarios for energy and emissions, hazardous material flows, and land-use and development are starting to be researched. This integrated vision for sustainable regionalism is largely based on the understanding that urban planning needs to give way to city-region (metropolitan) planning, and that urban management needs to lead to new modes of urban governance, in particular, integrated decision-making. While this new concept of urban governance may depend on long-term planning, partnerships, and coordinated action, it must rely on the use of information technology (IT) that will promote its goals of accessibility, accountability, transparency and efficiency. Through the Regional Workbench program, the SBRP Outreach Core aims to develop and explore a new framework for knowledge-based integration and navigation of distributed regional environmental data (KINDRED, an acronym coined by Richard Marciano, San Diego Supercomputer Center). This framework is standards-based and uses XML and Knowledge Maps for the organizing of integrated semantic views that bridge cultural, economic, and social contexts. Efforts are underway to develop a KINDRED "SPIRIT" testbed (SPatially Integrated Regional Information Testbed), focusing on the integration of land-use, toxics, and environmental health data in the San Diego-Tijuana cross-border region <see <http://kindred.sdsc.edu>>.



**Figure 10.** Binational Conference, June 2000, UCSD Logo design by Ben Tolo, San Diego Supercomputer Center



**Figure 11.** Tijuana Watershed in the San Diego-Tijuana city-region. Map by Ilya Zaslavsky, San Diego Supercomputer Center

Concern about the status of environmental health along the U.S.-Mexico border has captured the interest of the National Institute of Environmental Health Sciences (NIEHS). On June 12- 13, 2000, a Binational Conference was hosted by UCSD's SBRP to provide the NIEHS leadership with a strategic agenda and criteria for supporting future research on U.S.-Mexico related environmental problems. The June 2000 Conference was organized by Drs. Keith Pezzoli, John Helly, Palmer Taylor and Robert Tukey. Most of the 150 individuals who participated in the two-day event are research scientists, including 26 university colleagues from throughout Mexico. But a significant number of representatives from government, industry, and community-based organizations also took part. The Final Report for the June 2000 Binational Conference is now available on-line at [http:// www.sdsc.edu/niehsconference/report.html](http://www.sdsc.edu/niehsconference/report.html). The 80-page Report examines opportunities for and benefits of applying research results in biomedicine, information technology, environmental science, communications and social science to environmental health and management problems at the US-Mexico border. A key objective of the Binational Conference was to show how a strategic coalition of academicians, scientists, industry leaders, community-based organizations, and policy-makers in federal and local agencies with binational and border interests could be organized to pursue common problems. The UC Toxic Substances Research & Teaching Program (UC TSR&TP) was an important co-sponsor of the binational conference.

Upon the request of UCSD's SBRP Outreach Core, Congressman Bob Filner recently submitted a letter to Dr. Kenneth Olden (Director, NIEHS) in support of binational environmental research. Congressman Filner underscores the importance of building collaborative ties linking universities across the border. A selection from his letter is printed in the box below.

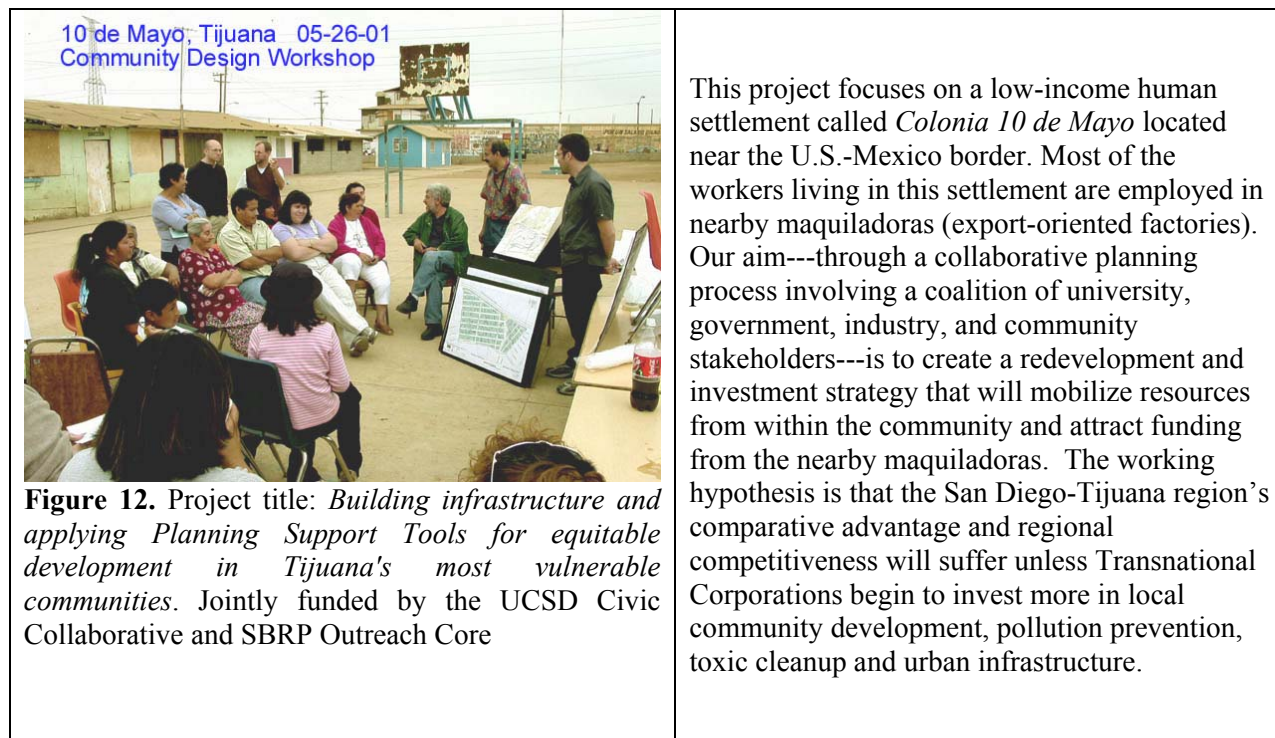
**Box 1. Excerpts from a Letter written by Congressman Bob Filner, dated September 13, 2001, in support of establishing a research-driven Mexico-U.S. Border Environmental Health Program**

As a member of Congress in one of the border states, I share your interest in not only defining the common environmental problems and health hazards along the border but also in developing remediation and infrastructure to address these issues. I understand that as a result of many Mexico-U.S. meetings attended by biomedical and environmental scientists, policy makers from border universities, and federal agencies from both nations, NIEHS has formulated plans to establish a Mexico-U.S. Border Environmental Health Program. I urge you to move forward to establish this program in the fiscal year 2003 budget.

The goal of a bi-national structure to handle the mounting environmental problems of this rapidly-developing region of the country is laudable. Eleven million people live along this 2000 border, which spans four U.S. and six Mexican states. The unforgiving climate and scarcity of water compound environmental, health and social problems in the region. Explosive growth in the southwestern United States, massive migration of Mexicans to better living opportunities along the Mexican border, and enactment of the 1993 North American Trade agreement have positioned this region to see a two to three fold increase in population by 2020. This growth will be accompanied by a major increase in traffic between the two nations as well as the resultant pollutants. The by-products of the industrial boom on the border will need to be handled properly in the United States or Mexico.

In the context of improving cross-border regional development, the SBRP Outreach Core is thus dedicated to generating synergy between advanced urban planning methods and emerging IT standards. The longer-term aims of the KINDRED initiative noted above project are: **(1)** developing a new framework to handle the growing needs for harmonization and integration of information across the border, especially concerning toxics and water quality, **(2)** developing and prototyping an integrated, land use system which will serve as key input for binational decision-making and conflict resolution at the watershed level. These objectives require additional support beyond funds available through UCSD's SBRP. Additional support is being sought from the NSF, UC Marine Council, and the UC Toxic Substances Research & Teaching Program System, among other agencies.

One of the specific Mexico-based projects the Outreach Core has jointly funded with support from non-SBRP sources is the *10 de Mayo* project. Details about this project are outlined in Figure 12.



## 6. Enabling collaboration through Memorandums of Understanding

### 6.1. Mondeca and Topic Maps

There is a pressing need for advanced tools and technologies to more efficiently access, navigate, search and visualize large, complex collections of information sources. To this effect an MOU was established between:

- UCSD's Urban Studies and Planning Program (Keith Pezzoli, SBRP Outreach Core, PI),
- SDSC's Knowledge-Based Integration (Richard Marciano and Bertram Ludaescher), and Spatial Information Systems Labs (Ilya Zaslavsky), and
- Mondeca, a French developer of advanced XML Topic Map technology.

Topic Maps are a promising approach to taming the explosion of information that is affecting all of society from science and industry to education and beyond, providing a powerful navigational tool for organizing, retrieving, and accessing information resources. Through the creation of an independent "knowledge layer" above the information resources themselves, Topic Maps make it possible to organize and federate information independently of location, format, or operating system. Topic Maps are an international standard, defined by the ISO (ISO/IEC 13250:2000), and can also be interchanged using the Extensible Markup Language (XML) as defined by the World Wide Web Consortium (W3C), XML Topic Map standard, XTM. To learn more about Topic Maps see [www.topicmaps.org](http://www.topicmaps.org).

"It will be helpful to work with the Mondeca researchers to use Topic Maps in several application areas that will provide practical experience and important insights into how best to use these evolving Topic Map tools and standards," said SDSC research specialist, Richard Marciano. In this collaboration,

Mondeca will provide SDSC with its advanced Topic Map software, which includes a suite of components and an SDK platform, and Mondeca and DICE researchers will work together using the tools to develop prototypes, as well as evaluating XML Topic Map standards. The application domain will be a collaborative Web-based network of researchers and community partners creating and linking knowledge for sustainable development in the combined San Diego, California and Tijuana, Mexico region. The researchers plan to use Topic Maps to create a cross-border, integrated view of land use in both the US and Mexico. "Because of the different units and ways of defining, measuring, and storing land use information in California and Mexico, it is very challenging to develop a single, integrated view of land use on both sides of the border, and we're looking forward to using Topic Maps to help accomplish this task," said Pezzoli.

Topic Maps are a content navigation and metadata metaphor designed to help users more efficiently find information, both inside the organization (intranet/extranet) and on the Web. "In the navigation paradigm of Topic Maps, users navigate through a conceptual space, which is a very different approach than now used in search engines like Google," said Ilya Zaslavsky. "At their simplest level, Topic Maps can be seen as an electronic version of the index at the back of a book," said Marciano. Like an index, the Topic Map presents an array of subjects, along with links to the occurrences of information, which are like the page numbers in the book index. But Topic Maps provide further important capabilities, including specifying multiple kinds of relationships between topics.

"Topic Maps are the 'glue' that links all the topics in a given area, letting users find the information they want more transparently by navigating through the concepts of the subject area, rather than having to know the underlying way in which the information has been organized and stored," said Zaslavsky. These graphical navigation tools present Topic Maps as spatial maps that allow users to have intuitive access to content via hypertree or spatial navigation tools. Users can access the content as a whole by "flying over" the Topic Maps. They can zoom in or out in this navigable semantic view of the information and choose different topics as the central node, with the other topics then re-folding around this node, providing the user with multiple different views of the same information. A topic-map like tree is shown in the following screenshot, which represents the Regional Ecology start tree.

## **6.2. TELESIS and the Quality of Life Data Initiative.**

In the context of developing the Regional Workbench program and internship opportunities for students, UCSD's Urban Studies and Planning Program has also entered into a MOU with TELESIS, a non-profit San Diego based corporation headed by David Cleveland. The mission of TELESIS is to provide leadership and expertise to health, education, and human services organizations who seek community based solutions for both organizational and community problems. The MOU establishes a joint working agreement between USP and TELESIS for the purpose of developing the San Diego Quality of Life Data Warehouse. This Project consists of a multi-agency strategic planning model, supported by social science research. Under this agreement each partner agrees to:

1. Participate in formal strategic planning and decision-making sessions with Project Partners,
2. Share data and other public information approved for general release that will pertain to the development of the Quality of Life Indices used to measure health, social, criminal, economic and environmental efforts throughout San Diego County and surrounding region,
3. Share subject matter and technical expertise regarding risk and protective factors and in developing science based composite indices, geographical information systems (GIS), and a world wide web site with inter-agency linkages,
4. Develop and adopt protocols for reporting progress and/or results to the media and the general public,
5. Participate in public policy meeting, conferences,
6. Participate in developing new advanced computer applications for data analysis,
7. Leverage funding resources and jointly seek additional funds.

## 7. Education Outreach: High School Student Interns Doing Basic Science Research Projects

In addition to involving undergraduate student research interns as part of the Regional Workbench initiative, the SBRP Outreach Core also has a major emphasis on high school students. The education partnerships, headed by Dr. Hyam Leffert, target environmental science curriculum development and teacher training in two of San Diego's disadvantaged high schools. Faculty mentors in the Outreach Core and SBRP science laboratories provide Student Interns with hands-on guidance in experimental research on waterborne toxicants.

To initiate various aspects of student participation in the Education Outreach program, two Preuss High School students, Eliana Rucobo and Fred Montgomery -- the first students to become basic science Student Interns in the Program -- created a **Teen Superfund Website** ([http://superfund.sdsc.edu/outreach/ely\\_fred/superfund.html](http://superfund.sdsc.edu/outreach/ely_fred/superfund.html)). Eliana and Fred learned computer website language and protocols with the help of Dr. P. Bourne and Ms. T. Battistuz at the SDSC. After learning about cell structure and function in the Leffert Laboratory, they wrote and presented a discussion about gene expression on their website. Then they researched and imported information on heavy metal and environmental toxicants into this site, and they added related URLs with the help of B. Tolo at the SDSC. Following these efforts, Eliana and Fred, working with Tae Chung (a UCSD work-study senior in the Leffert Lab), used their website experience and a digital camera to create the first version of the UCSD SBRP Outreach online **Lab Primer** ([http://superfund.sdsc.edu/outreach/lab\\_primer.html](http://superfund.sdsc.edu/outreach/lab_primer.html)). The purpose of this Primer is to provide visual and textual guides to basic science laboratory procedures and equipment in typical UCSD SBRP laboratories. The Primer will be updated as new students enter the program and are mentored by existing Student Interns.

**PROJECT HIGHLIGHTS.** Thus far, eleven students from Sweetwater and Preuss High Schools have joined the program. One student graduated and another had to drop out. Photographs and affiliations of all the students are shown on the Outreach Website. The basic science projects of the current students are summarized beneath each student's picture

### STUDENT INTERNS AND BASIC SCIENCE RESEARCH PROJECTS.



**Josephine Aguilar,**  
Junior, Sweetwater High School, Schroeder Laboratory, Biology Department, UCSD. Studying heavy metal transport in cultured plant cells. She is measuring stomata apertures in the cells and she is trying to understand what stimulates aperture opening.



**Luis Cruz**  
Senior, Sweetwater High School, Tukey Laboratory, Pharmacology Department, School of Medicine, UCSD. Purifying plasmids and studying UGT expression in cultured animal cells.



**Abelardo Hernandez**  
Junior, Sweetwater High School, Glass Laboratory, Department of Medicine, School of Medicine, UCSD. Studying the induction of macrophage genes by the cytokine, IL-4.



### Tamim Katawazi

Freshman, Preuss School, P. Taylor Laboratory, Pharmacology Department, School of Medicine, UCSD.

Learning to assay acetylcholinesterase and proteins. Acetylcholinesterase is the target of many insecticides, and Tamim will help to develop a novel assay to detect insecticides in water samples.



### Khang Nguyen

Sophomore, Preuss School, Karin Laboratory, Pharmacology Department, School of Medicine, UCSD.

Making plasmid preps and learning PCR in order to help create a **NOD2** knockout mouse.



### Eliana Rucobo

Sophomore, Preuss School, Leffert Laboratory, Pharmacology Department, School of Medicine, UCSD). Studying the dose responses at which heavy metals (Chromium[VI], Nickel and Cadmium) kill cultured rat liver progenitor cells, as well as the effects of iron[III] on the potential differentiation of these cells into blood forming cells (see Research Focus, below). Some of her work will be entered in the 2002 San Diego High School Science Fair

### Rudy Lopez

(2000 - 2001)  
Sophomore, Preuss School, Tebo Laboratory, Scripps Institute of Oceanography, UCSD



### Daniel Perez

(2000 - 2001)  
Senior, Sweetwater High School, Keiner Laboratory, Department of Pathology, UCSD



### Nancy Sandoval

Sophomore, Preuss School, Tebo Laboratory, Scripps Institute of Oceanography, UCSD. Studying mechanisms of the reduction of Chromium[VI] during aerobic growth of the marine bacterium *Shewanella putrefacens* MR-4. She hopes to identify key cellular proteins involved by analytical gel electrophoresis. Some of her work will be entered in the 2002 San Diego High School Science Fair.

### Fred Montgomery

Sophomore, Preuss School, Leffert Laboratory, Pharmacology Department, School of Medicine, UCSD.

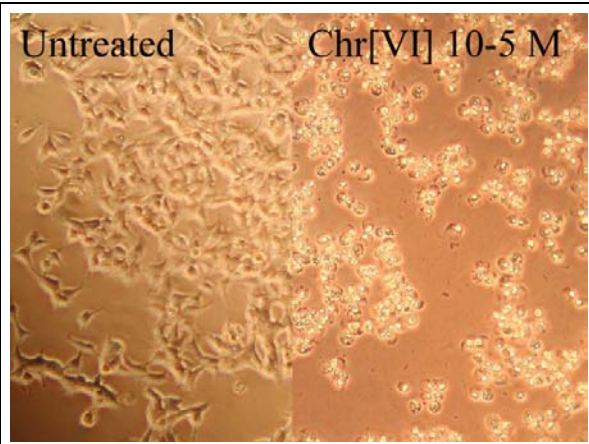
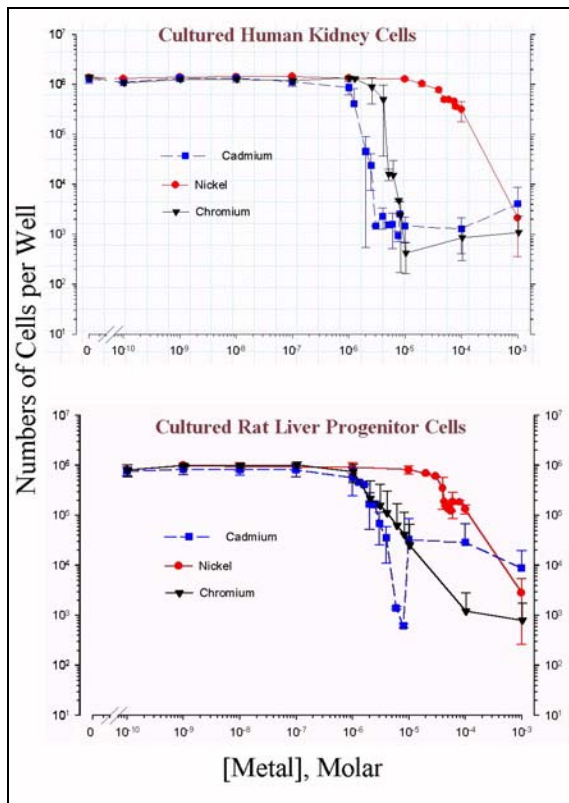
Studying the dose responses at which heavy metals (Chromium[VI], Nickel and Cadmium) kill cultured human kidney cells, as well as the rates and mechanisms of killing (see Research Focus, below). Some of his work will be entered in the 2002 San Diego High School Science Fair.



### Emily Robles

Senior, Sweetwater High School, Russell Laboratory, Molecular Biology Department, The Scripps Research Institute. Helping to identify novel genes involved in stress responses in fission yeast.

**STUDENT INTERN RESEARCH FOCUS.** Fred Montgomery and Eliana Rucobo (H. Leffert Lab), Preuss High School Sophomores, have investigated the lethal effects of three different heavy metals (Chr[VI], NiCl and CdCl) on two different species of **cultured animal cells**. Following plating and cell attachment at 24 h, the metals were added to the cultures and the surviving attached cells were counted 6 days later. The resulting dose response curves are shown below: **human kidney 293 cells** (top panel [a photograph of untreated cells and cells treated with  $1 \times 10^{-5}$  M Chr[VI] is also shown in the UCSD Superfund Summary Poster]), and **rat liver progenitor cells** (bottom panel).



**FIRST ANNUAL AWARDS CEREMONY  
September 15, 2001**



**Student Honorees 2001 and Program Officials Principals and Teachers**

[left to right] Hyam Leffert, Education Outreach Director; Fred Montgomery, Preuss High School Sophomore; Josephine Aguilar, Sweetwater High School Junior; Michael Karin, Scientific Director; Eliana Rucobo, Preuss High School Sophomore; Robert Tukey, Program Director.

[left to right] Ralph Mora, Sweetwater High School Principal; Doris Alvarez, Preuss School Principal; Geri O'Brien, Sweetwater High School Science Director; and Maureen Schimmer, Sweetwater High School Science Teacher.



**Josephine Aguilar and Family**  
[left to right] Father, Josephine, Mother, and Sister Joy.



**Fred Montgomery and Family**  
[left to right] Mother Cheri, Sister Cherron, and Fred.



**Eliana Rucobo and Family**  
[left to right] Brother Raul, Father, Eliana, Mother, and Grandmother Gloria.

### **WATER TOXICANTS AND REMEDIATION CURRICULUM (WTRC).**

Seven monthly WTRC Meetings (Water Toxicants and Remediation Curriculum) have taken place since November, 2000. Various UCSD SBRP Education Outreach Partners have attended the meetings, including teachers and principals from the Preuss and Sweetwater High Schools, Dr. Brad Tebo (an SIO scientist in the UCSD SBRP), Dr. Keith Pezzoli (UCSD SBRP Industry Outreach Director), and representatives of the UCSD SIO Birch Aquarium, the San Diego Natural History Museum, the UCSD Natural Reserve System, the SDSC Bioinformatics Group, and CREATE (a UCOP-sponsored program). Discussion topics have ranged from basic science (microarray, genomic, transgenic and knockout biotechnology) to coastal monitoring. As a result of these meetings, Dr. Pezzoli has initiated a key ocean and land mapping program, curriculum outlines have been described, new collaborations have been formed, and several outreach talks and seminars have been given at local high schools.

Most recently, the Preuss School at UCSD, one of our Outreach High Schools Partners, has incorporated the SBRP Student Intern Research position into its science Curriculum, under "Science

Research Techniques." Also, Dr. Ilya Zaslavsky recently gave a presentation to teachers at the Mission Bay High School Center for Coastal Studies and in the Magnet Schools Assistance Program. Zaslavsky's "coastal studies" outreach to teachers fits well with the SIO/3D modeling, and web-based GIS initiatives described above. This is a good example of how our effort to join education, industry, and governmental outreach comes together in mutually reinforcing ways.

## 8. Reports, Links, Publications



The NIEHS recently published a short article describing the RWB in the Journal: Environmental Health Perspectives Volume 109, Number 2, February 2001, see <http://ehpnet1.niehs.nih.gov/docs/2001/109-2/forum.html#net>. RWB links:

- RWB Web site <http://regionalworkbench.org/>
- On-line portal to undergraduate research in San Diego and Tijuana <http://www.regionalworkbench.org/sequence/expo/Expo2001/start/index.html>
- Graphical navigation and conceptual framework for accessing regional research projects and topics <http://www.regionalworkbench.org/sequence/Links/hexdiagram.htm>
- On-line interactive GIS mapping of toxics and other environmental variables in San Diego <http://superfund.sdsc.edu/gis/index.htm>

Binational Conference on Environmental Research and Policy, July 2000, UC San Diego. (with Spanish Translation). Funded by the NIEHS and the University of California, Toxic Substances Research & Teaching Program - UC TSR&TP <http://www.sdsc.edu/niehsconference/report.html>

Pezzoli, Keith (2000) Superfund Newsletter, *The NIEHS Binational Center Initiative, UCSD Superfund Basic Research Program*, Outreach Core. <http://superfund.ucsd.edu/news/html> >.

Pezzoli, Keith, Ilya Zaslavsky and Richard Marciano (2001). "Transborder City-Regions and the Quest for Integrated Regional Planning: Challenges posed by disarticulated infrastructures, fragmented ecologies of knowing, and uneven development." Paper presented at the World Planning Schools Congress, Shanghai, China, July 2001. [http://www.regionalworkbench.org/sequence/prof/prof\\_main.htm](http://www.regionalworkbench.org/sequence/prof/prof_main.htm)

### Scientific Publications

1] Fabregat, I., Koch, K.S., Aoki, T., Atkinson, A.E., Dang, H., Amosova, O., Fresco, J.R., Schildkraut, C.L., & Leffert, H.L. Functional pleiotropy of an intramolecular triplex-forming fragment from the 3'UTR of the rat Pigr gene. *Physiological Genomics* 5: 53-65, 2001 (<http://physiolgenomics.physiology.org/cgi/content/full/5/2/53>). Future Student Interns will study the effects of heavy metals on microsatellite instability in liver stem cells.

2] Yin, L., Sun, M., Ilic, Z., Leffert, H.L. & Sell, S. Derivation, characterization and phenotypic variation of hepatic progenitor cell lines isolated from adult rats. *Hepatology*, *in press* (2001). As described above (Research Focus), Eliana Rucobo will investigate the effects of heavy metals on liver stem cell plasticity using these novel cell lines.

## 9. Other References

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Source: National Research Council (1999) Our Common Journey: A Transition Toward Sustainability. Washington, D.C.: National Academy Press

Robert W. Kates, William C. Clark, et al. (2000) *Environment And Development*. Sustainability Science 27 April 2001 Vol. 292 (#5517): 641  
<http://www.sciencemag.org/>

## 10.Contact Information

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<sup>1</sup>The literature on sustainable development is vast and growing rapidly. For a fairly comprehensive, categorically organized overview see Pezzoli (1997a, 1997b). One can find work with an emphasis on cities (Satterthwaite 1999, Low 2000, European Commission, 1996, Pezzoli 1998, Beatly 1998, Carley and Kirk 1998); city-regions (Ravetz 2000), macro-regions (Gunderson et al. 1995); business (Hawkin et al 1999), sustainability science (NRC 1999); and radical theory (O'Connor 1994).

<sup>2</sup> See <<http://www.unep.org/unep/rio.htm>> <<http://www.un.org/esa/sustdev/agenda21.htm>>

<sup>3</sup> Herzog, Spalding, Ganster and Sanchez, Liverman et al, Ganster, Pezzoli, Institute for the Regional Studies of the Californias

<sup>4</sup> InterAcademy Panel on International Issues (IAP) Conference on the Transition to Sustainability, Tokoyo, May 15-19,2000.

<sup>5</sup> The title of this proposal is "Visualization for Planning: California Shoreline Data Integration." The PI is Steve Miller. Co-PIs include Keith Pezzoli, Graham Kent, and Neal Driscoll.