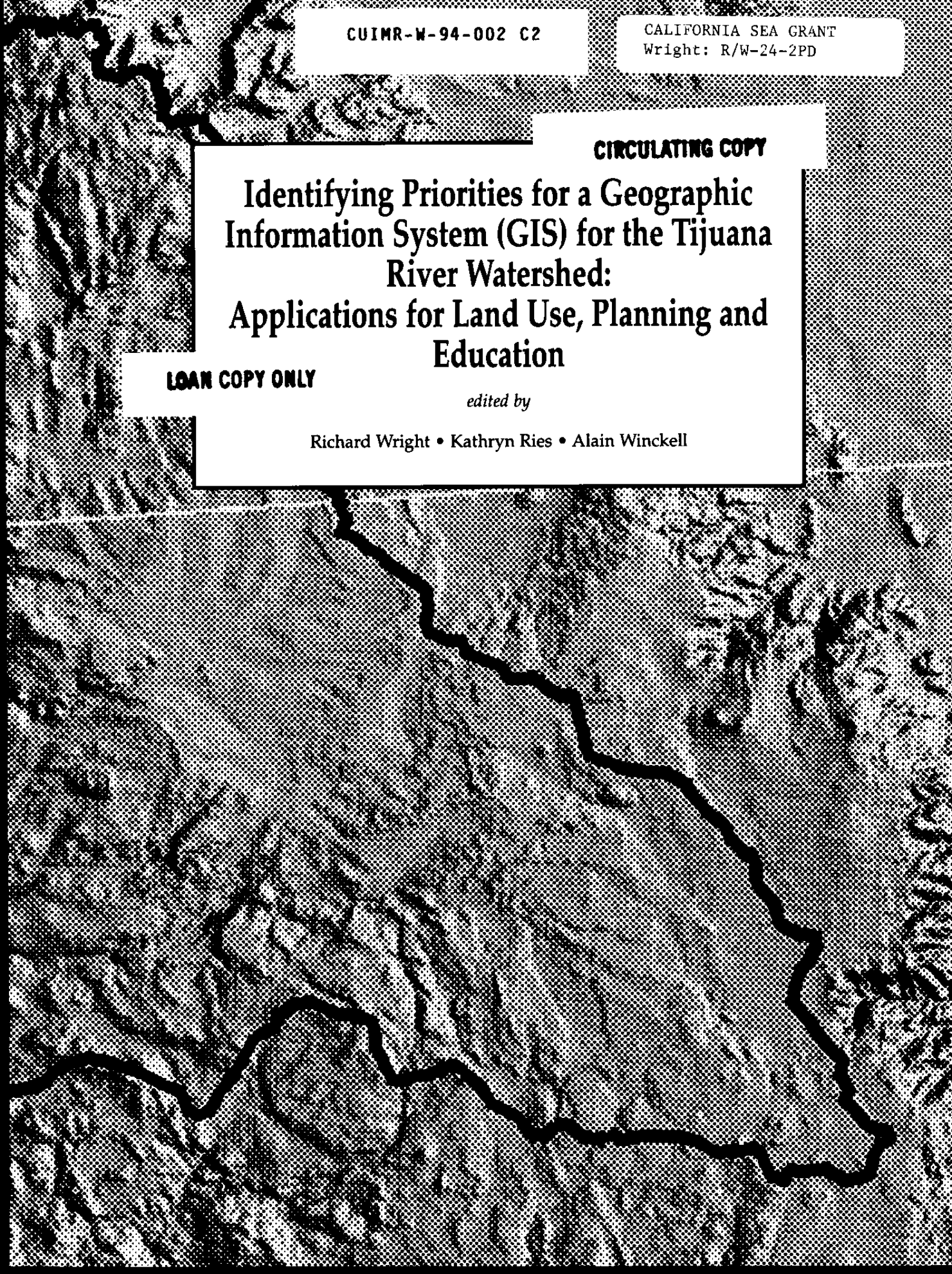
Identifying Priorities for a Geographic Information System (GIS) for the Tijuana River Watershed: Applications for Land Use, Planning and Education

edited by

Richard Wright • Kathryn Ries • Alain Winckell



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Cover illustration: The Tijuana River watershed. The thick black line delineates the boundaries of the Tijuana River watershed; the white line that crosses it represents the United States-Mexico international border. The terrain relief was provided by Alain Winckell and Michel LePage of COLEF-ORTOM, and was produced from USGS 1:24,000 and INEGI 1:50,000 digital elevation models utilizing SUN SPARC hardware and ARC/INFO and SIG-SAVANE software.

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1995

Published by
Institute for Regional Studies of the Californias
San Diego State University
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ISBN 0-925613-14-2

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FOREWORD

This workshop was sponsored and funded by the Department of Geography at San Diego State University (SDSU), El Colegio de la Frontera Norte (COLEF), the California Sea Grant College at University of California, San Diego, and the National Oceanic and Atmospheric Administration (NOAA). Local arrangements were handled by the Institute for Regional Studies of the Californias at SDSU, which is under the direction of Dr. Paul Ganster. Ms. Patricia Bennett of the Institute was responsible for communications, arrangements, and other details which were carried out efficiently and effectively. Also, she played a key role in assisting with the organization and editing of this report. The success of the workshop was due to the insightful contributions of the participants and especially of Ms. Karen Scarborough and Ms. Katie Ries who provided welcoming and overview remarks; Dr. Richard Wright and Dr. Gerardo Bocco who presented project and GIS overviews; Mr. Tom McDowell, Mr. Lorenzo Gómez-Morín, Dr. Mike Phoenix, Dr. Alejandro Hinojosa, and Dr. Barry Beasly who illustrated the use of GIS through a series of case studies; Mr. Kaare Kjos who described the Man and Biosphere project; and Ms. Nina Garfield who offered closing comments. Important input from the participants was obtained through the focus group sessions facilitated by Mr. Christopher Brown, Ms. Laura Durazo, Dr. Mike Phoenix, and Dr. Tom LaPointe. Dr. LaPointe also provided an orientation for the focus group sessions. Assistance to the facilitators was offered by rapporteurs Mr. Gerardo Chávez, Ms. Mary Henry, Ms. Laura Martínez, Mr. Mike Wilken, and Ms. Andrea Westersund. Finally, a special thank you is extended to the many persons who provided posters demonstrating various GIS applications in the Tijuana River watershed and adjacent areas.

Of these individuals, Dr. Alain Winckell and Mr. Michel LePage especially deserve recognition because of their GIS database development work on the watershed and their considerable efforts in preparing high quality map displays for the workshop. They have provided the illustrations in the appendix and the terrain relief model on the cover.

INTRODUCTION

by

Richard Wright

Department of Geography
San Diego State University

On September 30, 1994, the National Oceanic and Atmospheric Administration (NOAA) granted funds to San Diego State University (SDSU) and El Colegio de la Frontera Norte (COLEF) for the development of a binational geographic information system (GIS) for the Tijuana River watershed. The Tijuana River Watershed Management Project covers a 1,735 square mile drainage basin that straddles the California-Baja California section of the United States-Mexico border. Approximately two-thirds of the basin lies in Mexico with the remainder located in the United States. By supporting the development of the GIS, NOAA intends to encourage improved integrated management within the watershed to promote proactive protection of the Tijuana River National Estuarine Research Reserve (TRNERR), a reserve managed through a partnership between NOAA and the State of California Department of Parks and Recreation.

The TRNERR encompasses nearly 2,500 acres of the last remaining functioning wetlands in Southern California. The binational nature of the watershed provides numerous challenges and opportunities for the application of a GIS for basin-wide policy development and resource management. Other project components include social and political outreach, bilingual education and environmental awareness, and a comprehensive GIS to be shared equally by U.S. and Mexican users.

An important objective of this coordinated effort is to create a seamless database along the border between San Diego, U.S.A., and Tijuana, Mexico. This involves working with the cities and the San Diego Association of Governments (SANDAG) to develop common definitions and accuracy standards on topics that will be included in the database such as land use, transportation, and vegetation. Once this is accomplished, the GIS will be used to study a wide range of subjects such as environmental impacts of land use activities and alternatives for more efficiently managing transborder systems.

In order to assist researchers in shaping the development of the GIS, a workshop attended by more than 120 persons was held on November 29, 1994. The workshop, the first to be held in conjunction with the project, was intended to familiarize interested persons with the nature of the project. It was also designed to provide an opportunity for those within and outside of the watershed to begin to appreciate the role of GIS in establishing new directions in natural resources use and community planning. The specific objectives of the workshop were to provide

guidance to the binational project team in identifying:

1. Important planning and environmental issues in the watershed;

2. The types of thematic data that would be useful to communities within the watershed and those conducting scientific studies; and

3. The form of the products desired by prospective users.

This workshop report is divided into several parts. The Introduction describes the report and provides the project background. This is followed by the conclusions and recommendations that resulted from the meetings. Section I contains the text of the workshop opening. Section II provides an overview of the project as well as an introduction to GIS. Section III is a summary of six case studies that were intended to educate users about concrete applications of GIS. Section IV has summaries of four focus groups that centered on issues, data, and products. In conjunction with the focus group discussions, the participants completed a user profile and needs survey. The results of this survey are described in Section V. The next part of the proceedings, Section VI, contains the concluding remarks for the workshop that summarize the discussions and offer recommendations to guide further work.

A meeting of the project team and the advisory committee was held on November 30, the day following the workshop. The purpose of this meeting was to discuss the progress of the project and to consider various types of initiatives that should be undertaken. The minutes of this meeting are in Appendix A. The other appendices include the workshop agenda, the user survey form, a list of the GIS posters displayed at the workshop, and a meeting participant roster.

WORKSHOP OUTCOMES AND RECOMMENDATIONS

by

Richard D. Wright

Department of Geography
San Diego State University

During the course of the workshop the participants raised numerous issues relating to the project. These issues are summarized in the following statements.

1. Water pollution and inefficient water use are significant problems in this semiarid region.

2. The area's natural resources are being rapidly depleted through high population growth and urbanization.

3. Improvements in the region's infrastructure, (e.g., sewer and water lines,) are not keeping pace with population growth and the need for urban services.

4. Inadequate data exist concerning the demographic, economic, infrastructural, and environmental characteristics of the watershed.

5. Transborder communications and access to information about the watershed by students, residents, researchers, planners, and policymakers are inadequate.

6. Geographical data inconsistencies across the border make it difficult to conduct watershed-level planning.

7. Little transborder coordination exists among agencies that have digital mapping and planning responsibilities for the region.

8. Transborder asymmetries in technology, and funding and cultural differences are substantial.

Recommendations

A number of recommendations about development and use of GIS resulted from the discussions on watershed issues.

1. Consideration should be given to adding the following data to the GIS.

- Biological resources
- Sensitive species habitat
- Archeological resources
- Natural hazards
- Population distribution and other demographic characteristics
- Air flow and quality
- Chemical storage and solid waste sites
- Infrastructure (sewerage, water, energy, transportation)
- Water resources and use
- Livestock distribution

- Erosion potential

2. A study of current and projected water use in the basin should be conducted.

3. The effects of different sources of pollution should be analyzed.

4. Innovative planning techniques should be employed to make more efficient use of land to accommodate population growth and economic development while protecting the area's natural resources.

5. The project should continue harmonizing data across the border to facilitate watershed-level planning. Standards recommended by the two federal governments should be followed whenever possible.

6. Transborder coordination among agencies that have an interest in the watershed should be encouraged by providing financial assistance and in-kind help. A strong community coordination effort is critical to the success of the project.

7. Educational initiatives focusing on the development of instructional materials, such as videos, interactive computer graphics modules, and hard copy maps, should be undertaken. These materials should offer students and other interested persons easy access to local and watershed-wide information and the opportunity to enter data into the system.

8. Steps should be taken to improve communications with those who are interested in the progress of the project and use of the GIS. A quarterly newsletter reporting on project activities would be a significant step in improving communications.

9. GIS training workshops focusing on basin-wide spatial problem solving should be conducted.

10. Alternatives for the maintenance of the database after the project is completed should be evaluated in the coming year.

11. Products should be generated as soon as the data are put in digital form. These products could be in the form of 8.5" x 11" monochromatic illustrations.

I. Workshop Opening

Welcoming Remarks

by

Karen Scarborough

Office of the Mayor of San Diego

On behalf of Mayor Susan Golding, I would like to welcome you to San Diego and to comment on the significance of the Tijuana River Watershed Project and today's meeting. The Mayor hopes that this workshop is successful because what you do in the early stages in terms of setting priorities for GIS applications is most important for the effectiveness of the project.

The San Diego-Tijuana area is of great significance. The nation's eyes are on us, as are those of Canada and Mexico. The border is a hot topic these days and GIS is even hotter in the technology arena, so the two together are specially important. The Mayor and I feel that there is a great opportunity to cooperate binationally along the entire length of the border. The Mayor feels very strongly about binational cooperation and she has created a model to achieve it. She has established the Binational Planning and Coordination Agreement, signed by both her and Mayor Héctor Osuna, of Tijuana. This cooperative effort sustains, through regular quarterly meetings between the two Mayors and staff, the determination of solutions to critical cross-border environmental infrastructure problems.

Mayor Golding also strongly supports the North American Free Trade Agreement (NAFTA), which has helped increase exports to Mexico. In this regard, we have created a local NAFTA zone, a foreign trade area in the Otay Mesa region. Better transportation routes for this area, including highway 905, Otay Mesa Road, and the upgraded link between Calexico, Mexicali, and San Diego, are absolutely critical to NAFTA and are high priorities. Most recently the Japanese company Matsushita has decided to relocate its headquarters to San Diego and probably will have a maquiladora in Mexico.

Our Multispecies Conservation Program has introduced me to GIS and the importance of it as a tool for understanding the San Diego region. With GIS, we will be able to analyze the watershed on a much more regional scale than is now possible from our personal experiences. I have been involved with the Tijuana River quite directly as the Mayor's representative to a joint City-County task force that she and Supervisor Brian Bilbray put together to review issues in the watershed. Although this task force has been focusing on the piece at the mouth where the watershed contacts the ocean, the map clearly shows that the majority of the watershed lies in Mexico.

To conclude, the Mayor is delighted that there is this much interest regarding this issue. She hopes that you will have a suc-

cessful conference. Again, I welcome you to San Diego and hope that you can take this opportunity to find new ways of coordinating across a political line to fully address the natural systems that do not respect the international boundary.

Opening Remarks

by

Katie Ries

National Ocean Service
International Affairs Office
United States National Oceanic and Atmospheric Administration

It is a pleasure to be here and to see the diversity of participants at this workshop. You represent an impressive variety of institutions, agencies, various levels of government, sectors, and communities that have an interest in the Tijuana River watershed. Your interest, your support, and your participation are key to the success of this binational project.

First, I wish to say a few words about my agency, the National Oceanic and Atmospheric Administration, why we are involved in a project like this. Then, I will discuss the international context for this project.

In some ways it is ironic that the agency I work for is called the *National* Oceanic and Atmospheric Administration, because the resources that we deal with—air and water—do not recognize national boundaries. We have a mandate to conduct research and to monitor and assess changes in the atmospheric and marine environments. We also have responsibilities for managing coastal and ocean resources. These are responsibilities that we certainly cannot carry out by ourselves, not as a single agency and certainly not even as a nation, when those resources cross national borders. These resources that are so critical for human activities are being degraded, and in some cases depleted, as a result of the problems that we face at home. These problems include increasing population pressures, related economic development activities, and conflicting uses of resources. Such problems are not unique to the United States; they are shared by many countries and have received a great deal of international attention in recent years. But one of the lessons learned in managing these natural resources is that the interrelated social and economic factors that influence them must also be looked at. Resource management is really about changing human behavior, ultimately trying to influence how people interact with their natural environment. When natural resources are shared by two countries, as is the case with the water resources in the Tijuana River watershed, binational cooperation is essential, since their mutual use can so profoundly affect both countries.

Internationally, the need for a collaborative, integrated approach to achieve a balance between environmental protection and economic development has been recognized and articulated in many international documents, conferences, and conventions. The United Nations Conference on Environment and Development, held in 1992 in Brazil, galvanized international attention on the fact that develop-

ment practices that do not take environmental considerations into account destroy the very resources on which economic and social well being depend. The global action plan, Agenda 21, that came out of that conference called for sustainable development, which is learning to utilize and manage resources in a way that can meet not only current needs but also those of future generations.

There are also international legally binding agreements that have come into force in the last year and a half on such topics as climate change, biological diversity, and, most recently, on the use of oceans and coastal areas. The United Nations Convention on the Law of the Sea went into force just two weeks ago. These conventions require nations to come together to address issues that no one nation can effectively deal with alone. They call for countries to not only develop new relationships among governmental and nongovernmental agencies, the private sector, and community groups within their own countries, but also to forge new partnerships with other nations. Such partnerships are essential to carry out the kind of multidisciplinary research that is needed to understand some of these complex issues, to better collect and analyze scientific data, and, most importantly, to make the information available to people who are dealing with the day-to-day problems of resource management in local areas.

Mexico and the United States have a strong history of collaboration in many areas. However, the passage of the North American Free Trade Agreement (NAFTA) increases not only the opportunities, but also the challenges, for both countries. For example, there are environmental side agreements that were signed in conjunction with NAFTA. These recognized that the increased trade and the new commercial relationship between the countries could have adverse environmental consequences. The intent of the accords is to minimize or to mitigate those impacts as much as possible.

Presently, new border institutions are being created to try to address some of the environmental issues as this new trade relationship develops. For example, the United States, Canada, and Mexico have established a Trilateral North American Commission on Environmental Cooperation. As a part of the process of defining its agenda, this commission is looking at existing projects in the border areas and has already expressed interest in the Tijuana River Watershed Project. In the U.S.-Mexican border area, the Border Environmental Cooperation Commission (BECC) has been established and will be funded by the North American Development Bank. The purpose of the BECC is to work with U.S. and Mexican border communities to design, finance, and implement environmental infrastructure projects.

With the passage of NAFTA, we can expect to see social, economic, and environmental changes accelerate. To cope effectively with this kind of change, there must be a common scientific information base that can be used for making informed decisions and to provide a foundation for coordinated planning and utilization of shared resources. The reality is that most information has often stopped at the border and there have not been adequate mechanisms to share it. In recognition of this gap, binational efforts are underway to establish shared information databases, one of which is the focus of this workshop, the Tijuana River Watershed Project.

This project proposes to develop a geographic information system (GIS) for the Tijuana River watershed. Many of you might be aware of this technology, others might not be, but by the end of today you will know a lot more about it. GIS is a powerful information technology that can assist us in looking at the watershed in a holistic way, instead of being divided by political boundaries. I am not a GIS expert by any means, but my exposure to this technology demonstrates that its effectiveness lies in its capability to integrate different kinds of information. It brings information in a way that can provide new perspectives on current problems, and thus lay the foundation for formulating innovative solutions. The applications of this technology and the kinds of data that can be put into it are virtually unlimited.

Many of the workshop participants are planners or educators. Your involvement is critical for learning how to use the GIS for building public support at all levels for new development approaches in the watershed. We need your guidance on how this technology and database can best serve your needs, since you are the people who must make decisions that affect resource management and, ultimately, the quality of life in the Tijuana River watershed.

Although this is a project with a specific regional focus, the issues that are being dealt with are a microcosm of what is being looked at internationally. There is tremendous interest in this project, and it is only seven months old. The reason for this interest is that the project is addressing the topic of how to facilitate, over the long term, a different approach in dealing with the shared environment and ultimately improving the quality of life for everyone concerned with the watershed. What you are doing here is important not only for yourselves and the watershed communities you serve, but for the international community that is looking for successful models to follow.

II. Project Overview

The Tijuana River Watershed Geographic Information System: A Tool for Shared Management

by

Gerardo Bocco

Departamento de Estudios Urbanos y del Medio Ambiente
El Colegio de la Frontera Norte

Introduction

The Tijuana River watershed is an area shared by the United States and Mexico. In this almost 4,500 Km^2 area, two-thirds of which is located in Mexico, both countries face interrelated socioeconomic, political, and environmental problems that transcend the national borders.

Some of the social problems, e.g., non-planned urban growth or the decline in public health, cannot be detached from environmental problems such as the deterioration of drinking water quality or increasing pollution and erosion.

The North American Free Trade Agreement (NAFTA) encourages the possibility of solving those problems through a joint effort. There is a need for analytical and environmental instruments to formulate descriptive models to represent actual and hypothetical situations and predict possible courses of action. The combined technologies of remote sensing and geographic information systems (GIS) offer alternatives for the efficient management of geographical areas and the maintenance of accurate data and information. These characteristics allow us to conceptualize the GIS for the Tijuana River watershed as a management tool, within a framework of sustainable development and a binational perspective.

Objectives and Scope of the System

The main objective of this project, funded by the National Oceanic and Atmospheric Administration (NOAA), is to develop a spatially referenced socioenvironmental database, that may be utilized by communities and organizations from both sides of the border, to facilitate decision making within the concept of shared management of the Tijuana River watershed.

In order to reach this goal, the project has four specific objectives:

1. The production of a GIS;

2. The propagation of information to communities and organizations;

3. Environmental education and the use of GIS; and

4. Research development.

These objectives are reflected in the thematic elements of the GIS.

GIS Thematic Elements

The GIS involves the development of scientific, socioeconomic, educational, and

environmental management as thematic elements. The project is based on the design and production of a GIS as a cooperative effort between San Diego State University (SDSU) and El Colegio de la Frontera Norte (COLEF/ORSTOM).

An initial, critical phase consists of the standardization of the data so that the database will be compatible for both sides of the border, according to the norms set by the Instituto Nacional de Estadística, Geografía e Informática (INEGI) and the United States Geological Survey (USGS). The GIS will be developed using modern photogrammetric techniques, satellite imagery, aerial photography, and the integration of multiple databases.

At this point, we have completed aerial photography at a scale of 1:50,000 for the entire area. This was done by the National Oceanographic Service (NOS) of NOAA through a permit facilitated by the Instituto Nacional de Ecología (INE-SEDESOL). The input of the existing basic cartographic data at 1:50,000 is in different stages of processing.

The sociopolitical element will provide social, economic, and political-administrative data that will be included as layers in the GIS. The GIS capabilities will also be used in projects that will encourage environmental education relating to different aspects of border activities. In general terms, the GIS is intended to provide a tool to facilitate the integrated management of the watershed. By providing a substantial amount of information, the GIS will widen research possibilities for themes such as geomorphology, hydrology, comparative studies of land use, landscape ecology, urban-regional development, and the process of environmental degradation.

Organizational Element

To carry out the project, a management team was formed, consisting of people from SDSU, COLEF, and various academic, government, and nongovernmental organizations such as Universidad Autónoma de Baja California (UABC), Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Instituto de Culturas Nativas de Baja California (CUNA), and Pro-Esteros.

An advisory committee has been formed, and organizations such as Comisión Internacional de Límites y Aguas (CILA), Dirección General de Ecología del Estado de Baja California, Instituto Nacional de Ecología (INE), and Comisión Nacional del Agua (CONAGUA) have been invited to participate.

Technical Element

The core of a GIS is formed by its human and conceptual elements, with the technical element also having a fundamental role. The essential value of a GIS is its analytical capability. A common data structure will be used on both sides of the border. The technology and data transfer arrangements have been formalized through a specific agreement between SDSU and COLEF.

Conclusions and Perspectives

The development of a GIS for the shared management of the Tijuana River watershed provides a unique opportunity along the U.S.-Mexican border. A successful experience could be a model for similar efforts. In any case, this project will provide the border community with many learning opportunities.

In the application of remote sensing and GIS, the technical aspects are usually highlighted. These technologies have been sufficiently tested as tools for environmental management. However, the organizational and cultural aspects need to be further analyzed because they are more complex. A GIS is a tool; it can only process data, not create magic.

Environmental issues are inherently complex. When these are based in a border region, such as that of the United States and Mexico, their complexity can increase dramatically. The GIS and the database are models, or systematic descriptions, of reality. The challenge is to create common binational models that can be represented adequately by the GIS data. This can only occur with the continued and patient work of the project team and the support of the community.

Overview Outline of Geographic Information Systems (GIS)

by

Richard Wright

Department of Geography
San Diego State University

A. Definition of a GIS

- Systems, information systems, and geographic information systems
- Data information, knowledge, and decisions
- GIS as a decision support system

B. GIS versus automated mapping

- Topology
- Area definition, connectivity, contiguity

C. Questions a GIS can answer

- What is at a particular location?
- Where is a particular feature?
- What has changed since a particular time?
- What are the spatial patterns in a particular area?
- What if ...?

D. Steps in the GIS process

- Data acquisition
- Data input
- Management and storage
- Analysis
- Display

E. Major components in a GIS

- Hardware
- Software
- Peopleware
- Data
- Applications

F. Major GIS data models

- Raster
- Vector

G. Contributing disciplines and technologies

- Geography
- Statistics
- Cartography
- Operations research
- Remote sensing
- Computer science
- Photogrammetry

- Mathematics
- Surveying
- Geodesy
- Many application areas

H. Major application areas

- Street network-based
- Natural resource-based
- Land parcel-based
- Facilities management

I. Summary

III. GIS Case Studies

Multiple Species Conservation Program: An Integrated Raster/Vector Model

by

Tom McDowell

Ogden Environmental and Energy Services

In the past, planning for environmental preservation in the United States often took a fragmented, project-by-project approach, leading in some cases to a set of isolated patches of environmentally important habitat. Many states, cities, and counties have begun to recognize the importance of establishing a program to preserve habitats for federally endangered, threatened, or key candidate species on a larger or regional basis. The Multiple Species Conservation Program (MSCP), initiated by the City of San Diego, has taken such an approach to identify habitats of significant size that can maintain biological diversity and protect self-sustaining, viable populations of sensitive species. To accomplish these objectives, an integrated raster/vector GIS model was developed which prioritized critical, biological resources based on four model components:

1. Key California gnatcatcher habitat;

2. An overall habitat value index (derived from seven separate factors including biodiversity, species richness, and edge effects);

3. The known distribution of federally and state listed sensitive species; and

4. Potential wildlife corridors.

This presentation describes the methods used to model these components using GIS and discusses problems encountered in operationalizing several factors. It also summarizes the advantages of using both raster and vector formats to solve environmental problems. The general applicability of using a multiple species approach to identify critical habitat when planning for growth on a regional basis is discussed.

Environmental Planning for the Tijuana-Ensenada Coastal Zone

by

Lorenzo Gómez Morín

Dirección de Investigación y Posgrado
Universidad Autónoma de Baja California

I will relate some experiences that the Universidad Autónoma de Baja California's (UABC) environmental management team has had in environmental planning for the coastal corridor between the cities of Tijuana and Ensenada. Team members include Ana María Escofet, Ileana Espejel, José Luis Fermán Almada, and me.

Any environmental planning project in Mexico must comply with the Ley General de Equilibrio Ecológico y Protección al Ambiente (General Law of Ecological Balance and Environmental Protection) of 1988. In Baja California, projects must also comply with the State's Ecological Balance and Environmental Protection Laws. This is important because every environmental management project is derived from the ecological law whose objective is to preserve and restore, if necessary, the ecological balance of the environment.

The Programa Regional de Desarrollo Urbano, Turístico y Ecológico del Corredor Costero Tijuana-Ensenada (Regional Program for Urban, Tourist, and Ecological Development for the Tijuana-Ensenada Coastal Corridor) was initiated two years ago to fulfill the need for a planning instrument that would regulate the region's growth. The corridor is an area of high economic growth, calculated at about 4.4 percent per annum for the last ten years. This growth, particularly in the urban and tourist sectors, caused the coastal zone to be a strategic area at national, state, and federal levels. For the most part, the urban and tourist growths have been unplanned with severe environmental consequences in some areas. The need for integrated planning and environmental conservation has been recognized by all levels of government.

The general objectives of the Coastal Corridor Progam were:

1. To establish appropriate land use and regulations for conservation of natural resources within the coastal corridor; and

2. To provide a planning tool for zoning activities and land use. A specific objective was to design a GIS that could be used for planning purposes.

The program was headed by a technical committee consisting of representatives from many agencies including the Secretaría de Desarrollo Social (SEDESOL), Secretaría de Turismo (state and federal tourism offices), Fondo Nacional para el Fomento al Turismo (FONATUR), Secretaría de Asentamientos Humanos y Obras Públicas del Estado (SAHOPE), Dirección General de Ecología (General Office of

Ecology), and the municipalities. Three groups conducted the study: A private consulting company provided urban development information, COLEF generated data concerning the tourist sector, and UABC analyzed the project's ecological component.

A series of problems and opportunities were identified within the corridor. The problems involved environmental deterioration with opportunities in such areas as preservation of natural habitats and sensitive species. With public participation, and taking into account the problems and opportunities identified, the goals and objectives of the project were established and the economic activities and developing areas of the corridor were characterized. Once the goals and objectives of the project were established, an evaluation of the physical and human environments was carried out.

In order to describe and inventory the physical environment, the corridor was divided into homogenous regional levels represented at different scales. The different levels are:

- Ecological zone
- Coastal province
- Region
- System
- Subsystem
- Natural unit

The coastal province level could have been divided following any number of criteria, e.g., regional geology, morphotectonic units, hydrography, and climate. Regions were divided according to social problems and economics. Systems were defined according to oceanographic and hydrologic criteria. Subsystems were defined on the basis of geomorphologic and vegetation criteria, and natural units according to the oceanographic, geologic, geomorphologic, and vegetation characteristics.

The characterization of the physical environment and the environmental evaluation for land use are technical problems that are relatively easy to address. The more difficult problems are those associated with generating land use alternatives, developing a management plan that would satisfy population needs, and implementing the management plan.

A strategy of use and management of natural resources and coastal ecosystems should be an integral part of the management proposals. It should consider environmental, social, economic, and political criteria for each land use or activity. A set of environmental regulations should be determined for each management unit to include policies for a range of land uses from "no development" and restricted use to totally unrestricted urban development.

The implementation aspect of the project consists of three elements:

1. Administrative instruments including those relating to the prerogatives and responsibilities of the government offices in charge of the program's management;

2. Judicial instruments such as those that form the legal foundations; and

3. Financial instruments which are the income sources for the accomplishment of the goods and objectives.

This project has demonstrated that the management of coastal physical resources and ecosystems is a governance issue. The program has resulted in decisions by gov-

ernment organizations that are unrelated or not integrated with those made by other entities. This raises a jurisdictional question, namely, who should be responsible for decisions regarding natural resource management? In Mexico, there is no single government organization responsible for the coastal zone.

These issues should be considered at the outset of a project. Even with effective technical instruments, if the administrative and judicial frameworks are not adequate, it will not be possible to monitor the results of a project. Any project that does not have adequate implementation standards may be a valuable experiment, but only as an academic exercise.

Use of GIS in Education

by

Michael Phoenix

Environmental Systems Research Institute, Inc.

GIS is exploding across the American educational community. Over 500 universities in the United States are doing something with GIS; what is more interesting is that it is also spreading across disciplines. The user departments include criminal justice, entomology, political science, geography, forestry, planning, and other disciplines that use spatial information. The job market is causing this explosion, with many jobs available that use GIS technology. Universities have been slow to build the programs because the technology is expensive, and it takes a lot of time and effort to learn it. But students are demanding it and the universities are responding.

GIS is having an impact at all educational levels, including K-12 and the community colleges. There are different things happening at the K-12 level than what is happening at the universities. But as GIS spreads, one of the things that has come across very clearly is that the center of GIS is spatial analysis, not making pretty maps and putting them on the wall. GIS is not pretty pictures, it is spatial analysis. An understanding of spatial analysis is the key to effective use of a GIS.

One of the difficulties in a university program is that technology and spatial analysis are taught at the same time. They require more than a couple of years to learn, which is a problem considering that must students do not settle on a major until their junior year. It is hoped that the spread of GIS into K-12 will answer some of the needs of the universities. Universities need to have incoming freshmen who have a fair degree of spatial literacy. I am not familiar with the situation in Mexico, but in the United States geography has been woefully neglected in K-12. In many states, it appears not at all or has been subsumed into social studies, which is mostly history with very little geography. Hopefully, this is changing in favor of more geography.

As we focus on K-12, we run into a different set of problems. The focus shifts away from technology to geographic literacy for the reasons that the technology is fairly expensive, the software is fairly complicated to learn, and the number of schools and teachers is very large. We need to look at how we address the needs of the K-12 with GIS. GIS is an engaging technology in that it captures the interest of the student, and is graphic, colorful, and interactive. It is something that is natural to the Nintendo generation that we have in the United States. It is also an integrating technology since it permits the integration of many different disciplines into an exercise in a classroom setting. It is also an enabling technology that provides new perspectives because it allows for completion of activities that could not be accomplished before.

A project like this is a good fit with education, as it is engaging, interesting, and integrative. This information can be put into the hands of K-12 teachers. The major stumbling block in making the project materials accessible to the students is making them accessible to the teachers and teaching the teachers. This is a challenge that has been laid at the doorsteps of the universities. But there is a lot that government agencies can do with environmental education to bring children and teachers to an outreach center.

There is a tremendous educational opportunity with the Tijuana River Watershed Project and its focus on the management of an international river basin. Recently, at our user conference, we had a group of 12, 13, and 14-year-old school children do a presentation on their GIS projects. At the end of the students' talks, their teacher gave a presentation to several thousand people. During the presentation, she indicated that in addition to being a teacher, she was also a citizen advocate. She raised a very good point, for if an individual takes an important issue to children, they will carry on with that issue. If one really wants to make a change in something like water conservation, watershed management, or water quality, it should be done through the children, the next generation. We can engage them in this technology and involve them in this process. They will get excited about it and run with it. You, as community leaders, parents, teachers, and government representatives, can take this Tijuana River Watershed Project to your community and get people excited about it. Then, real change will come.

Geological Risk Zoning in the City of Tijuana Using a GIS

by

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A. Background

1. Population growth in the City of Tijuana

- Economic development and the maquiladoras
- Flow of work force to the border region

2. High demand of land for human settlements

3. Settlements in unsuitable areas

- Canyons
- Steep slopes
- Unstable slopes

4. Occurrence of landslides in populated zones

5. Landslides triggered by rain and development

B. CICESE's geological study

1. Study requested by municipal authorities of Tijuana

2. Study showed that landslides occur in areas of:

- Steep slopes
- Highly fractured rocks
- Unconsolidated sedimentary rocks

C. Locating risk zones with a GIS—Step 1

1. Generalize findings of study to the entire city

2. Use of GIS to automate the process

3. Data included in the GIS: Slope, faults or fractures, lithology

D. Locating Risk Zones with a GIS—Step 2

1. A closer look

2. Risk zones determined by slope threshold

3. Refining the data

- Higher resolution
- Geology remapped
- Faults and fractures reexamined
- Modified definition

4. Delimitations of five risk zone categories with different degrees of danger

The Edisto River Basin Study: A Case Study of GIS Use and Public Policy

by

Barry R. Beasley

South Carolina Department of Natural Resources

The Edisto Basin Study in South Carolina originated through a grant from the National Oceanic and Atmospheric Administration (NOAA) as a research and demonstration project. The project has two objectives:

1. To develop a geographic information system (GIS) for natural resource management applications in the Edisto River Basin; and

2. To develop public policy procedures to identify the public interest in natural resources, to classify and prioritize natural resources by value, and to formulate alternative approaches to environmental management and regulation.

The GIS database for the 3,100 square-mile watershed is mapped at a scale of 1:24,000. The database contains over twenty layers of information including land use, soils, wetlands, transportation routes, hydrography, and political boundaries.

Three baseline studies of the basin were completed as the data were being collected. These studies were an ecological characterization of the basin, a socioeconomic analysis, and a public opinion survey.

The next step was to design a study process that would:

1. Allow the GIS database to be a policy tool;

2. Maximize citizen involvement;

3. Potentially create alternative approaches to environmental management; and

4. Link economic development with natural resources management.

To accomplish these objectives, we created a two-phase process beginning with an evaluation and assessment of the basin's resources followed by the creation of a management plan.

The process was initiated by appointing a thirty-eight-member citizen's committee called the Edisto Basin Task Force to serve as the chief decision making body for the study. Fifteen members of the task force chair expert committees, which are comprised of resource experts and basin citizens. The expert committees are responsible for the evaluation and assessment. There are over one hundred and fifty individuals involved in the Edisto Basin study.

Currently, we are still in the evaluation and assessment phase of the study. This

should be concluded by the summer of 1995 and the full study completed by early 1996.

In a complex study such as this, key issues surface as the process moves forward. The following is a brief overview of six of these issues:

1. *Building the database.* If the database is to address policy issues, make sure policymakers are involved in constructing the database.

2. *Clarity of purpose.* Define the goals and objectives of the study as clearly and concisely as possible. People are typically accustomed to planning for a specific problem such as a single parcel of land, not a watershed.

3. *Develop "spatial literacy."* Utilizing GIS as a policy tool requires people to conceptualize maps differently. They must think in terms of spatial relationships at the landscape level in a watershed study.

4. *Public involvement.* If you call your study citizens-based planning, make sure the public has true input, a real decision making role. Make decisions early as to how the public will be involved.

5. *Watershed planning and political boundaries.* Watershed and political boundaries typically do not match. Decisions may be based on political boundaries. This needs to be addressed in a watershed study.

6. *Creating and understanding of GIS as a policy-making tool.* For many people GIS maps are abstract in concept and GIS applications in natural resources management at the watershed level is a new concept. It can take time to understand GIS as a policy-making tool.

The Tijuana River Watershed International Biosphere Reserve Project

by

Kaare Kjos

Tijuana River Watershed International Biosphere Reserve Project

The Tijuana River Watershed International Biosphere Reserve Project is a binational coalition formed with assistance from the Environmental Protection Agency to seek biosphere reserve designation for the Tijuana River watershed. The coalition is composed of the Tijuana River National Estuarine Research Reserve (TRNERR), the Southwest Center for Environmental Research and Policy (SCERP), San Diego State University (SDSU), Universidad Autónoma de Baja California (UABC), El Colegio de la Frontera Norte (COLEF), and Habitat Integral, S.C. The biosphere reserve project is part of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere Program.

The purpose of the proposed biosphere reserve is to monitor and conduct multidisciplinary research of natural resources and socioeconomic activities within the Tijuana River watershed, and to share this information with an international network of more than three hundred and twenty biosphere reserves in over eighty countries. The long term objective is to prepare a management plan for the entire watershed that incorporates the needs and interests of its stakeholders and reconciles conflicts where they may occur.

There is a direct linkage between the GIS and the proposed biosphere project. Mapping the entire watershed via GIS will provide an inventory of natural resources and certain human activities. Comparing this information to previously collected data, as well as data to be generated in the future, will contribute significantly to the comprehensive overview so essential to the biosphere reserve program.

The Man and the Biosphere Program was initiated by UNESCO in 1971 to address the broad range of human activities and their effect on the natural environment. The goal was to link environmental resource conservation with the preservation of indigenous cultures and the promotion of socioeconomic development. In seeking a balance between these often competing forces, the program implements the concept of sustainable development.

The program was further defined in 1974 by calling for special sites, or "Biosphere Reserves," representative of biogeographic areas that would be linked through conservation and socioeconomic development.

A biosphere reserve has three components:

1. Core (Protected Area) where natural resources occur in their most pristine form. Human intrusion and activity is minimal or nonexistent;

2. Buffer (Managed Use Area) where some controlled human activity occurs, such as national parks, Indian reservations, and the like; and

3. Transition (Zone of Cooperation) where more intensive human activity occurs.

The biosphere reserve program is unique for several reasons. First, it combines several functions into one single site and links these sites to an international network. Second, it recognizes that humans are a part of the ecosystem and that human development has a constructive role to play in the protection of natural resources. Biosphere reserves can contribute to the positive development of the region.

One of the challenges of establishing a biosphere reserve is the identification of the many stakeholders within the reserve boundaries and their respective interests, agendas, and responsibilities. It is important to acknowledge that many of these stakeholders may be operating at cross-purposes, knowingly or unknowingly. The goal is to recognize the broader consequences of the various activities and to seek an overall management structure that will bring these activities into greater harmony with each other.

In 1984 an Action Plan was adopted by the Man and the Biosphere Program which clarifies the objectives for the biosphere reserves:

1. Each biosphere reserve will be part of an *International Network.* As of March 1994, there were three hundred and twenty-three biosphere reserves in eighty-three countries (forty-seven in the United States);

2. Each biosphere reserve should have an overall *Management Plan* to reconcile conflicting activities;

3. In situ *conservation,* along with *multidisciplinary research* and *monitoring,* are fundamental activities within a biosphere reserve.;

4. Managing biosphere reserves calls for holistic, *regional planning* with active *local participation;* and

5. *Education, training,* and *information* sharing serve to promote the benefits of biosphere reserves.

In the 1980s, representatives of the TRNERR Management Authority and SDSU initiated efforts to designate the Tijuana River watershed as a biosphere reserve after recognizing the adverse impact the heavily polluted Tijuana River was having on its estuary. This attempt was not successful due, in part, to the disturbed nature of the estuary, considered a candidate "core" area, as well as the low priority given such matters by the federal government.

The effort was renewed in early 1994 with a small grant from the Southwest Center for Environmental Research and Policy. A binational team has been assembled and is currently preparing the required documentation. While the ultimate goal is to establish one biosphere reserve over the entire watershed, with one overall management plan, the responsible officials in both Mexico and the United States have strongly suggested that separate designations for the portion in each country in-

itially be pursued. Once established, these two reserves would then be integrated.

The procedure to establish a biosphere reserve differs slightly in the two countries. In Mexico, documentation is prepared according the criteria established by SEDESOL (Secretaría de Desarrollo Social). If approved by that agency, the application then is forwarded to the President and, with his approval, goes to Man and the Biosphere (MAB) headquarters in Paris for final consideration.

In the United States, documentation is prepared according to guidelines currently being revised by the Biosphere Reserve Directorate. This documentation consists of a UNESCO nomination form and a feasibility report. The feasibility report provides justification for a biosphere reserve, nominates core areas, identifies and documents the support of stakeholders, and describes the proposed management structure. After consideration by the Biosphere Reserve Directorate, the application is reviewed by the national MAB office before being sent to Paris.

It is essential to recognize the many activities and projects that relate to the proposed biosphere reserve in the Tijuana watershed. Among these are:

1. The Peninsular Ranges Transborder Biosphere Reserve Project (Mt. San Jacinto, Palomar Mountain, Cuyamaca Mountain, Parque Nacional Constitución de 1857, San Pedro Mártir) that is adjacent to the boundaries of the proposed Tijuana River watershed biosphere reserve;

2. The Multiple Habitat Conservation Plan (MHCP);

3. The Multiple Species Conservation Plan (MSCP);

4. The Geographic Information System (GIS) of the watershed being prepared by SDSU and COLEF with start-up funding from NOAA;

5. A GIS of the California-Baja California section of the U.S.-Mexican border being prepared by the Department of Geography at SDSU with funding from the Southwest Center for Environmental Research and Policy;

6. Wildlife forums held to promote bioregional conservation and planning balanced with anticipated economic development;

7. The Tijuana-Ensenada Tourist Corridor Plan; and

8. A GIS of Northern Baja-California being prepared by COLEF/ORSTOM.

Perhaps the most difficult challenge in establishing a biosphere reserve is obtaining the support of the stakeholders, i.e., the many actors within the watershed who work and live there, who impact the activities of others, and in turn are impacted by the same. A workshop will be held in the near future for stakeholders and other interested parties. For more information, contact the offices of the Tijuana River Watershed International Biosphere Reserve Project: Tel: (619) 285-1725; and Fax: (619) 285-9432.

IV. Summaries of Focus Groups

Orientation Outline for the Focus Groups

by

Tom LaPointe

National Ocean Service
United States National Oceanic and Atmospheric Administration

A. Primary questions for the focus groups to consider

- What are the important potential uses of GIS?
- What kinds of geographic data are needed to address the potential users?
- What types of products are best suited for specific types of uses and users?

B. Everyone is a potential user of the GIS

- If you use maps you are a potential user
- GIS experience is not required
- Computer knowledge is not required

C. Keep the GIS focus in mind

- The entire Tijuana River watershed (1,735 square miles)
- The nominal resolution is 1:50,000
- The project will result in a complete and spatially consistent database

D. Identifying uses

- Primarily to provide a structure or framework
- To anchor discussions in the real world
- Choose two or three good examples
- Do not get bogged down in details

E. Specifying information needs

- Be as specific as possible
- Set priorities because resources are limited
- Be reasonable concerning available data versus data that must be developed
- Whenever possible, note sources

F. Types of products

- Simple is best
- Avoid the electronic trip. How much computer is enough?
- The printed page is still supreme
- Consider standard versus custom products

G. Some final words

- Focus on content. Avoid computer talk
- Think short-term and what is possible

- Represent both yourself and your institution
- Be realistic about data and GIS assimilation
- Be concise and brief in your comments

GIS and Environmental Planning

by

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A. General Topics and Issues

1. Philosophical issue of sustainable development—How can we use this project and GIS to aid us in creating systems of sustainable development that allow reasonable levels of employment, income, and provision of basic human needs while also insuring that resources and environmental quality will remain to allow the same for future generations?

2. Policy issue of purpose of this workshop—Are we trying to craft and fashion a set of objectives, goals, and a plan on how to achieve these, or are we trying to design and implement a Tijuana River Basin GIS project?

3. Policy issue of top-down or bottom up processes—Is this project intended to work via a model of top-down or bottom up implementation? The former works from a set of preestablished objectives and goals and seeks to implement via a hierarchical plan. The latter seeks input and consensus from the user community concerning the objectives and goals of the project and what data and analysis are needed to achieve these goals and objectives.

B. Specific Problems and Issues of Interest to the Environmental Planning Focus Group

1. Issues related to water resources were ranked as most salient:

   a. Balancing competing needs of provision of water supply with those of adequate quality and quantity of surface and groundwater; how to provide adequate water quality and quantity, and for whom; dealing with the conflict of human versus wildlife uses;

   b. The modelling and management of sediment loads and industrial and residential wastewater; and

   c. Development of a comprehensive basin-wide water balance, a real world hydrologic cycle including storage, movement, sources, inputs, and outputs, both intra- and inter-basin in nature, with respect to ground and surface water.

2. Issues related to human resources and impacts on the natural environment of the basin:

   a. Provision and preservation of recreation resources for human beings;

   b. How to meet the demand for basic human needs (housing, employment,

environmental safety and health) for the residents of the basin;

c. What the impacts of increasing human population on the basin, specifically involving cross-media (air, water, and land) dynamics are; and

d. How to model and preserve archeological and past historical and cultural resources and sites.

3. Issues related to the biodiversity of the basin:

a. The treatment of humans and their artifacts as components of the ecosystem in the basin;

b. Issues concerning biological reserve design and creation, especially with respect to corridors for adequate movement of species; and

c. The study of salt water intrusion and sea level rise, especially with respect to the estuary.

C. Specific Products Desired by the Environmental Planning Focus Group

1. Layers or specific data to be input into the system—land use, land cover, land ownership, soils, existing biological reserves, sensitive species habitat, well locations, vegetation, archeological resources, topography, hydrological and geological hazards, fire hazards, land use compatibility (derived), and land use planning and zoning.

2. Maps depicting spatial distribution of these phenomena—water level contours (surface and ground), wells, existing and future water demand, groundwater contamination, ecological associations, ecological reserves, urban land uses, patterns of electromagnetic reflectance of hazardous materials, location of toxic materials, and erosion and geological hazards maps.

3. Technical reports describing research into specific topical areas—basin-wide hydrologic cycle report, presence and risk from hazardous materials, standards for data and metadata included in the GIS, and a matrix that presents the products, uses, and source data involved in the project, similar to Berry's geographic matrix (Berry, 1964).

D. Unresolved Issues: Topics for Future Discussion and Resolution

1. U.S.-Mexican asymmetry of resources and experience—Ing. Rascón, CILA's (Comisión Internacional de Límites y Aguas) representative mentioned their binational experience of dealing with a marked asymmetry concerning information technology (IT) capability, desires and needs for data sharing, and training and experience of respective staff. This asymmetry should be acknowledged, and the project should strive for a harmonization of data sharing, IT capability, training and technology transfer, taking into account the sovereignty and autonomy of each country and their respective researchers and policymakers.

2. Policy issue of the purpose of this workshop—People in this focus group closed with a desire to learn "more about the project," especially with respect to the questions raised earlier of whether we are trying to craft and fashion a set of objectives and goals and a plan on how to achieve these, or whether we are trying to design and implement a Tijuana River Basin GIS project. Included in these comments is the related issue of whether the project is intended to work via a model of top-down or bottom up implementation.

That the latter approach is being emphasized in this project is evidenced by this workshop, the primary purpose of which is to obtain input and direction from perspective users of the GIS in the early stages of its development.

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GIS for Urban Planning

by

Laura Durazo

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Ayuntamiento de Tijuana

A. Potential Uses

1. Diagnose, plan, and communicate the present status and options for sustainable management concerning the following issues within the watershed:

a. Resource allocation and conservation

- Water resource management
- Soil management
- Air quality management

b. Economic development as it relates to land use planning and capability issues

c. Wildlife, including marine preservation (landscaping, habitat, restoration)

d. Physical infrastructure

- Wastewater management infrastructure
- Hazardous and nonhazardous waste management infrastructure
- Transportation and communications

e. Social infrastructure (hospitals, schools, parks, housing)

f. Identification of hazards (natural and industrial) and contingency plans

B. Kinds of Geographic Data Needed

1. Vegetation
2. Human settlements
3. Political landscape
4. Projected population growth
5. Demographic profiles
   a. Urban areas
   b. Rural (suburban) settlements
6. Soil classification
7. Climate
8. Air flow and quality
9. Topography
10. Hydrology (marine included)
11. Location of industry
12. Pollution emission inventory
13. Chemical storage

C. Products

1. Land ownership mapping
2. Land use mapping
3. Natural resource (and resource management) mapping
4. Binational differences in utilization rates of resources in the watershed

5. Maps (digital and paper), workbooks that are visually interpretable and easily accessible (useful to everyone in both

English and Spanish)

6. Mapping should be subregional

7. It should be easy to query data

D. Special Concerns

1. Products should be cost effective

2. There needs to be more transborder interaction and communication

3. It is important to harmonize management criteria

4. Further identification of stakeholders would benefit the GIS development process

GIS in Education Focus Group Report

by

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The GIS in Education Focus Group came up with a list of issues that should be addressed and considerations that are important if this GIS system is to have an educational component. The group's points are as follows:

1. The maps should show the watershed as a region, something with which the students can identify. They should display the region as a whole, not bisected by a border, and something that portrays the students' local area as an integral part of the region.

2. The group members believe that school children need to be able to locate themselves on the map. They want to be able to see their house, school, and street, and locate these in reference to other things. If teachers have a copy of a map that shows their community with its vegetation types, this will allow them to walk out of the school and around in the community and say: "this is on the map and this is what it looks like in reality." They need to be able to take an aerial photograph and compare its perspective with the horizontal view of reality. This access to local information will make the GIS real to them, something with which they can identify, and something that they can use.

3. The GIS should provide a way for students to input data into the system. For example, students could go out on a regular basis and collect water quality data or a soil sample, or do some vegetation mapping from an aerial photograph and put this back into the system. Additionally, the students could do some ground truthing. This has worked in other places. Having the students collect vegetation, health, or erosion data does not have to be a complicated problem, just something simple that gets them involved with the project. The important thing is for students to feel that they are an important part in making the GIS work.

4. There is a need to make this function across the border. Perhaps this could be accomplished by collecting data from both sides of the border and putting it in a map, or perhaps having graduate students from both sides of the border, working jointly on some project. One of the more difficult things to achieve is cross-border communication, particularly in the education arena, with the different educational systems. But there may be some way that we can build transborder education into the GIS.

5. There are a few products that people believe are useful for education. Video technology is widely available. A video could help students learn about the project and about the watershed. They can see how the data is used.

A central repository for maps is needed so that students or teachers who want to

look at a certain aspect of the problem can easily obtain maps on vegetation, erosion or other subjects. In general, the layers of information required for education will not be different from the layers needed for the GIS. There is a need for access to the information in an inexpensive and hands-on format so the students with no knowledge of GIS can examine the data.

Lastly, the GIS in Education Focus Group wants to see maps that show change in the local area. This will allow the students to do simple overlays showing, for example, how their community is losing important vegetation types. These are some of the activities that could be carried out using the kind of data proposed for the GIS.

GIS Outline for Specialists

by

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National Ocean Service
United States National Oceanic and Atmospheric Administration

A. Issues Raised by the Group

1. Data inconsistencies across the border

   a. Accuracy and generalization variables

   b. Attribute variations

   c. Uniform standards are needed

2. Importance of watershed level planning

   a. The needs for the City of Tijuana planning are different than those of the watershed as a whole

   b. A need exists for common georeferencing systems, scales, and ellipsoids

   c. A need exists for cooperation among agencies that have responsibilities for large scale mapping—NOAA, USGS, and INEGI

   d. A need exists for a common database with a standard structure

3. Importance of metadata and data dictionary

4. Problems in the watershed

   a. Flood control

   b. Surface water quality

   c. Groundwater quality and aquifer depletion

   d. Water supply for agriculture, human consumption, commerce and industry, and wildlife.

   e. Protection of habitat areas

   f. Transportation inefficiencies

   g. Erosion

B. Data Needs

The data needs are largely in response to the aforementioned problems in the watershed. Specific data needs are:

1. Water use
2. Water importation
3. Water quality
4. Monitoring stations
5. Hydrographic features
6. Climate
7. Sewerage systems
8. Land use
9. Agriculture
10. Demography
11. Point sources of pollution
12. Livestock distributions
13. Land development and construction

14. Slope

15. Vegetation

16. Erosion potential

C. Product Desired

1. Regularly update data dictionary

2. Raw data are more important than derivative products

3. Example products

4. Technical report on the database

D. Other

1. An electronic (Internet) system of communications should be established to link users.

2. There is a need to educate potential users about the limitations and advantages of the database and GIS.

3. Maintenance of the database is critical if it is to be used on a continual basis.

V. User Profile and Needs Survey

User Profile and Needs Survey

During the focus group sessions, participants were requested to complete a user profile and needs assessment questionnaire, a copy of which is included as an appendix. The purpose of the questionnaire, was to obtain information such as expectations and needs for GIS products covering the watershed. The following paragraphs are a synopsis of the responses to the most pertinent questions.

1. Profession

As Table 1 indicates, most of the respondents were environmental professionals.

Table 1
Professions

Professions	U.S.	Mexico
Environmental specialist	12	3
Hydrologist	5	-
Environmentalist w/gov.	4	4
Research & development	3	7
Ecosystem health design	2	1
Environmental planning & regulations	8	9
Archaeologist	2	-
Economist	1	1
Marine biologist	2	1
Cartographer	2	-
Hazardous material specialist	1	-
Education	5	4
Computer sciences/GIS	6	4
TOTALS	53	34

2. Interest in the Watershed

The participants expressed a strong interest in the coordination of environmental education, planning, and management across the international boundary.

Table 2
Interest in the Watershed

Topic	U.S.	Mexico
Natural habitat coordination and planning	11	7
Data coordination at the Border	12	3
Public education	5	1
Research	4	4
Water services	3	2
Air and water quality	7	2
Conservation of resources	4	5
Flood protection	2	2
Water management	4	4
Land use analysis	-	3
TOTALS	52	33

3. Most Important Planning and Educational Issues

Each participant was asked to list the three educational and/or planning issues considered to be most important. As expected, most of the issues thought to be important relate to water quality and quantity. On the one hand, participants from the United States placed more importance on water issues, possibly because many of the impacts relating to water quality and quantity come to a focus in the Tijuana River estuary on the U.S. side of

the border. On the other hand, Mexican participants placed much greater emphasis on the matter of population distribution, reflecting their concern about the relatively uncontrolled growth of housing in the Tijuana region and the relation between that growth and erosion and infrastructural deficiencies.

Table 3
Most Important Planning and Educational Issues

Issues	U.S.	Mexico
Flood management	10	1
Land use planning	5	4
Groundwater	10	-
Water availability	-	3
Water quality & sewage flow	9	-
Surface water	5	1
Tidal impacts	2	-
Erosion	-	2
Inventory biodiversity	5	-
Sustainable development	2	2
Pollution sources	13	6
Ecosystem approach in planning	4	1
Environmental impacts	4	-
Legal and administration	1	2
Hazardous materials information	2	-
Separating shared resources	1	-
Transborder standardization	3	1
Access to publications	2	-
Bilingual materials	1	-
Wildlife management	6	-
Environmental resource planning	5	2
Infrastructure	3	3
Accessibility to work stations	2	1
Economic activities	7	6
Transborder transportation	2	2
Population distribution	-	8

4. Ranking of Thematic Layers Already Planned for the Database

The participants were provided with a list of thematic layers already planned for the database. In general, the basic layers of topography, hydrography, land use, and land cover were thought to be most important. It should be noted, however, that the Mexican participants also rank geology and economic topics highly.

Table 4
Ranking of Thematic Layers (Weighted Averages)

Themes	U.S.	Mexico
Topography	4.28	4.28
Hydrography	4.44	4.64
Geology	3.89	4.16
Demography	3.56	4.04
Economics	3.47	4.28
Boundaries	3.60	3.56
Climate	3.39	3.76
Land use	4.30	4.56
Land cover	4.48	3.88
Agriculture	3.64	3.80
Soils	3.80	3.76
Point layers	4.05	4.36

5. Other Types of Data Desired

The participants indicated that many other types of data should be added to the basic layers. These topics are shown in Table 5.

Table 5
Other Data Desired

Water quality
Groundwater
Land ownership
Sources of pollution
Hazardous materials
Air quality
Erosion hot spots
Sensitive species
Industrial development
Sewer lines
Other utilities
Transportation

6. Level of Familiarity with GIS Capabilities

The majority of the participants indicated that they had an understanding of GIS and its capabilities that fell between no understanding and a full understanding.

Table 6
Level of Familiarity

Level	U.S.	Mexico
No understanding	5 (10%)	2 (9%)
Some understanding	28 (60%)	17 (74%)
Full understanding	14 (30%)	4 (17%)

7. Level of Experience with GIS Technology

In general, the participants were relatively inexperienced in the technical aspects of designing and operating a GIS.

Table 7
Level of Experience

Level	U.S.	Mexico
Experienced	19 (40%)	14 (61%)
Some experience	20 (43%)	6 (26%)
Very experienced	8 (17%)	3 (13%)

8. Products Needed

The participants expressed the desire to obtain a wide range of products from the GIS.

Table 8
Products Needed

Products	U.S.	Mexico
Thematic maps	33	19
Base maps	36	14
Graphs	22	11
Statistical tables	21	13
Digital data	30	18
Analysis database	28	16
Processed digital data	27	16

9. Level of Detail Required

Most of the participants were interested in obtaining data for the watershed at resolutions in the 10 to 100 meter range.

Table 9
Level of Detail Required

Resolution	U.S.	Mexico
Kilometer	7	6
Hectometer	20	10
Decameter	22	5
Meter	14	-

10. Typical Extent of Area that would be Examined

In general, participants expressed an interest in conducting studies at all levels: regional, county, and community.

Table 10
Typical Extent of Area that Would Be Examined

Area	U.S.	Mexico
Regional	31	15
County	26	14
Community	27	9

11. Types of Computer Used

At this time, the participant organizations emphasize the use of PC and Macintosh computers.

Table 11
Types of Computer Used

Computer	U.S.	Mexico
PC	25	16
Macintosh	15	1
IBM Main Frame	5	6
SUN/UNIX	5	2

12. GIS Software Installed on the Organization's Computers

ARC/INFO and ARCVIEW are clearly the most commonly employed GIS software, although it is noteworthy that the user friendly ARCVIEW has not yet penetrated the organizations of the Mexican participants.

Table 12
GIS Software Installed

Software	U.S.	Mexico
ARC/INFO	17	7
ARCVIEW	12	-
ILWISS	1	2
SPANS	1	3
MACGIS	1	-
Map INFO	3	2
ERDAS	2	3
GRASS	1	2
ARC/CAD	1	-
AUTOCAD	-	2
CISIG	-	1
ATLAS	-	1
IDRISI	-	2
HORIZON	-	1
Do not know	6	2

VI. Closing

Closing Remarks

by

Nina Garfield

National Ocean Service
Sanctuaries and Reserves Division
United States National Oceanic Atmospheric Administration

When I began working on this initiative to develop a binational geographic information system (GIS) for the Tijuana River watershed I knew little about the technology of GIS or the issues confronting the San Diego-Tijuana border region, other than what had been publicized in the media. Initially, I served more or less as a conduit between the development team in the field and the funders in the National Oceanic and Atmospheric Administration (NOAA). Working in collaboration with experts from multiple disciplines in this region, we marketed the initiative as a model of sustainable development. Academic concepts of integrated social, economic, and environmental planning were to be applied to the seemingly cliché concept of sustainable development.

It was a smart proposal. Now, one year into the project, I have come to understand the value of our approach, the human challenges we face in implementing the initiative, and the responsibility we have to this region to ensure that this effort continues. I believe, based on what I have learned over the course of the first year of the project and heard and discussed today, that what we proposed initially was challenging, in some ways overly ambitious, and in other ways, it does not go far enough. I would like to touch briefly upon our opportunities, challenges, and responsibilities at this pivotal point in the project.

The goal of the project is to produce a geographical information system (GIS) for the Tijuana River watershed. Unlike most GIS initiatives, we did not define a specific application for the GIS. We articulated the need as the development of coordinated databases and maps that transcended the border to improve urban and regional land use planning. Driving this need are the highly publicized environmental and social problems that have characterized this region for decades. It has become nearly impossible to discuss solutions to environmental problems without addressing related social problems. A GIS represents a way to discuss both social and environmental variables in a new integrated light. GIS also depicts how the two issues are so integrally linked and provides the basis for seeking new approaches to urban and environmental planning. It provides the information structure to address sustainable development.

The binational project team envisioned a well structured project in which a core management team would serve as a decision making hub for subcommittees specializing in GIS, education, sociopolitical outreach, and management. Each subcom-

mittee would be binational in membership.

Developing a GIS of this scope faces two challenges. One challenge is the technical feasibility of choosing standards that make sense to real-world problems while coordinating with existing and future data needs of both countries sharing this watershed. The parallel challenge is to define the application of immediate priority which is the process we began today. Ultimately we should choose an application with the broadest relevancy and which can be addressed by the integration of existing data. However, a useful result of the process will be the identification of information gaps and how this should guide future research within the watershed.

A larger question that must be addressed is what institutional mechanism will be used or developed to coordinate watershed wide planning and education. Barry Beasley's presentation begged the question of the need for a larger institutional framework to take responsibility for the GIS process and basin-wide planning. Perhaps it is to early to undertake such an initiative. Certainly the institution would look very different for this binational region. Does the political will exist on both sides of the border to coordinate planning for the future? If so, how will the results and products of this project facilitate the planning effort? Until these questions are addressed, this project exists in a political and social vacuum. Watershed coordinators are needed on both sides of the border to begin institutionalizing and focusing these efforts.

This project is about more than funding the development of a database from which maps can be produced and environmental processes modeled. This project is about initiating a process involving people living and working within the watershed to come together and find common grounds across borders and disciplines. Our cultures are not accustomed to gathering scientists, government officials, planners, teachers, engineers, and others together to address various issues in our communities, within our respective countries, not to mention between countries.

The most interesting outcome of this workshop was the recognition that, while there are so many critical issues within the watershed in many different disciplines, there is a recognizable theme that unites the seemingly disparate agendas. Out of each discussion group—education, planning, and GIS—the question of water quality and quantity was raised repeatedly. These fundamental issues raise questions about population growth, urban water treatment and supply infrastructure, erosion control, habitat protection, housing development, and education needs among students, the public and private sectors, and decision makers.

Water is the most basic resource that determines the boundaries of healthy population growth. As we look into a future of rapidly increasing population concentration in this region, in part due to NAFTA, we need to ask ourselves, what kind of environment do we want for our children and grandchildren? The planning begins today. The choices that were made, or not made, within the past fifty years resulted in the problems we deal with now. We cannot afford to repeat the mistakes of the past. Innovative approaches to understanding issues and addressing problems are needed, and this GIS aims to be the scientific and technological support system to begin that process. We cannot reject

new ways of doing business and addressing problems simply because they are new or because there are no markets for new technologies.

Today marks a kind of rite of passage for this area as we step into a more responsible, yet somewhat unknown, approach to managing the watershed resources. But it is clear that it must be accompanied by a political rite of passage. Without the institutional structure to be accountable for the long range vision for the watershed, the vision will quickly dissipate and business will continue as usual. I believe that as this day marks the beginning of a new dialogue in this community, the cities of Tijuana and San Diego are also initiating a new dialogue. We heard the representative of the Mayor of San Diego mention the agreement signed between two mayors to coordinate planning efforts.

The challenge you face is to coordinate the social and political processes, so you continue to receive political support and maintain the dialogue between the communities to articulate the future vision for this region. When Beasley spoke of the highly complex and integrated process that was undertaken in the Edisto River Basin, it became clear to me that what we lack here is the political leadership that was enjoyed in that watershed. This effort is a bottom up approach in which the public is driving the agenda. But while we need to influence political leadership within this region, we need to realize that binational projects are uniquely complicated. There is education to undertake to raise awareness and alter perceptions of the interrelatedness of problems, and there is trust to be established. There has never before been an opportunity to view this watershed on one large scale map and identify relationships between otherwise distinct variables. To have supportive and supported leadership, there must be an educated populace and a congruence on the issues and solutions.

Thus, today was a very important day in beginning to articulate the diverse critical issues that this watershed faces. For many of us, it was the first time that we gathered together as leaders within a shared community, the Tijuana River watershed. Our team has the overwhelming responsibility to provide you with a meaningful GIS and products that are relevant to you. We will do that by mid-1996. But you have an even more daunting challenge, and that is to put the GIS to use at the local level in your work: as teachers, to raise new questions among your students about the symbiotic relationship between human activities and environmental issues; as engineers, to develop the means by which innovative, cheaper, and more efficient technology can steer our society into a more beautiful and sustainable direction; as academics and scientists, to provide the meaningful research and data to support this new vision; and as philosophers, to question the integrity of decision making in our educational, social, and political systems.

VII. Appendices

Appendix A

Minutes of the November 30 Meeting of the Project Team andAdvisory Committee

An Advisory Committee meeting was held on November 30, 1994, the day following the workshop, and was attended by 18 persons (see list of participants following this section). The agenda consisted of:

1. A status report on GIS database development;

2. A description of membership changes in the project's core binational team, and

3. The identification of major issues and future directions.

A. GIS Database Development

An overview was given on aerial photography, satellite imagery, and the development of metadata and specific thematic layers, including topography, hydrography, geology, climate, land use, vegetation, soils, demography, and geomorphology. Important issues raised in the discussion include staff and funding shortages faced by SDSU and COLEF for the GIS activities, the importance of completing metadata, and the need to identify a future home for the GIS with an organization that will be willing to update and maintain it and provide access to its products.

1. Metadata

Richard Wright and Alain Winckell have been working on metadata development but have not given it adequate attention because of staff and funding shortages and the delay in obtaining a formal agreement between COLEF and SDSU that would permit data exchange. The institutions were encouraged to ensure that this element is consistent with U.S. Federal Geographic Data Committee Standards. It is also important for the Mexican agency INEGI and the U.S. agency USGS to be involved in the project because of their mapping responsibilities in the border region. INEGI and USGS representatives were at the workshop and expressed strong interest in the project. USGS and INEGI are already conducting joint border projects.

2. Aerial Photography

The aerial photography has been completed and processed. A complete set of 1:50,000-scale georeferenced color photos has been delivered to SDSU and a second set has been ordered for the Mexican partners. The first portion of the overflights covering the Tijuana River National Estuarine Research Reserve was done in February with the remainder, including coverage of the Islas Los Coronados, completed in August. A NOAA/NOS representative offered to provide a copy of the flight index so that the photographs can be identified at specific points along the flight lines.

3. Satellite Imagery

SPOT satellite imagery (10 meter panchromatic) for the watershed has been identified for June 1993. The digital elevation model created for the project will be employed to create a georeferenced, terrain-corrected version of the imagery. The SPOT imagery will be ordered in early January.

4. Topography

Digitized 1:50,000-scale INEGI maps for Mexico have been merged with USGS 1:24,000 DEMs for the U.S. to produce the first borderless layer in the Tijuana River watershed database. SDSU hopes to eventually replace the 1:24,000 DEMs with scanned elevation data from USGS 1:24,000 topographic maps.

5. Hydrography

The linear hydrographic features have been digitized and merged. Point and polygon features are scheduled next for digitizing and merging.

6. Geology

This is still at the inventory stage as data sources are still being investigated.

7. Climate

COLEF has been collecting climate data for both sides of the border for approximately twenty-three U.S. stations and twelve Mexican stations. It was noted that the data are insufficient for modeling storm events.

8. Land Use

Once the satellite imagery is received, the compilation of land use information will be initiated. SPOT panchromatic imagery, aerial photography, and possibly Landsat imagery will be employed for creating the land use layer. It was noted that SANDAG and the City of San Diego recently signed an agreement to integrate land use and zoning data across the border.

9. Vegetation and Land Cover

As with land use, the creation of the vegetation/land cover layer will be initiated with the receipt of the satellite imagery. A lot of vegetation mapping has already been done on the U.S. side by SDSU, SANDAG, the County of San Diego, and other organizations. Future activities will focus on working with Mexican researchers to complete the vegetation database on the Mexican side. The project needs to consider planned database updates by other entities. For example, SANDAG staff plan to update their land use and vegetation databases for the U.S. side beginning in the summer of 1995.

10. Soils

The data for the U.S. side have been digitized from 1:24,000-scale Soil Conservation Survey maps. Comparable data for the watershed south of the border do not exist and will have to be estimated by correlating soil types with environmental variables on both sides of the border.

11. Demography

COLEF has digitized some data from both sides of the border, but this layer (actually many layers) still requires much work. Tim Trainor, the U.S. Bureau of the Census representative, stated that data are available for U.S. boundary areas and can be obtained on INTERNET, although they may be too broad for the types of analysis desired in the project. He will investigate whether

the Bureau is interested in doing a more intensive pilot project in the watershed to provide more detailed information for this layer. Also SANDAG has detailed data on demographics that may be useful.

12. Geomorphology

This thematic layer relates closely to many other layers such as land use, soils, geology, and vegetation. It is useful for erosion analysis and many other applications. Alain Winckell will provide guidance to Gerardo Chávez, a Mexican Geology graduate student from CICESE (Centro de Investigación Científica y Estudios Superiores de Ensenada), who will be collecting geomorphological data. A classification system has yet to be developed.

B. Changes in Project Membership

The COLEF representative Gerardo Bocco has been replaced by Vicente Sánchez, and the Tijuana Planning Department representative Jesús Verdín has been replaced by Laura Durazo. Durazo has substantial environmental expertise and would like to facilitate a more formal Mexican institutional network to support the project. For example, the Mexican agency SAHOPE (Secretaría de Asentamientos Humanos y Obras Públicas del Estado) regulates land use outside cities or municipalities and should be a partner. Other partners could include state environmental authorities (Departamento de Ecología, Baja Norte, Secretaría de Agricultura y Recursos Hidráulicos, Comisión de Servicios de Agua del Estado) that are in charge of wastewater management.

The group cautioned about adding other partners before the project has anything concrete to offer. The project should not appear to promise more than it can deliver as it is only in the early stages. It was emphasized that, at this point, other partners should be sought that can offer resources, financial or in-kind, to the project.

C. Major Issues and Future Directions

The group felt that the GIS portion of the project was well underway and that it was time to develop supplemental projects on education and public outreach. A major obstacle is the lack of an institution that can provide staff time to develop these elements, develop proposals, and solicit funding. There was extensive discussion about the nature of outreach and education that are inextricably linked to the project's short- and long-term goals. A great deal of debate took place trying to define realistic and feasible aims.

Sustainable development of water resources in the watershed is a lofty long-term goal, but is extremely sensitive politically and could potentially bog down the project in the near term. The project could be perceived as competing with the political players in the region that make water use decisions. Analysis of water use and supply would also require more data layers and a level of resources that go far beyond the current project scope that is scheduled to end in early 1996. Yet, the group concurred that it was important to demonstrate the potential of this GIS before the project ended, so that it would not be viewed as a generic database that had no relevance or application to real-life problems and activities.

The final consensus was to focus on an educational approach and produce from

three to five 8.5" x 11", black and white watershed maps in a folio format. They might contain a simple analysis of a non-controversial topic that could be readily reproduced (photocopied) and distributed to a variety of organizations, including schools, businesses, and planning entities. Such maps could be a simple first step to stimulate thinking and promote GIS "literacy" referenced in the workshop. They could be relatively inexpensive to reproduce (as opposed to a color atlas, for example) and could begin to sensitize public awareness of various issues and needs.

This proposal would be a manageable first step that could integrate both the education and outreach components and allow the project to solicit outside funding without taking on too great of a new effort. This effort could perhaps be combined with a few more workshops to further the awareness of the use and potential of the GIS, particularly by decision makers, an important target group.

Appendix B

Members Present at the Advisory Committee Meeting

Guillermo Alvarez	Universidad Autónoma de Baja California
Barry Beasley	South Carolina Department of Natural Resources
Gerardo Bocco	El Colegio de la Frontera Norte
Christopher Brown	San Diego State University
Laura Durazo	Tijuana Planning Department
Pat Flanagan	Tijuana River National Estuarine Research Reserve
Nina Garfield	National Oceanic and Atmospheric Administration, National Ocean Service
Peter Grose	National Oceanic and Atmospheric Administration, National Ocean Service
Alejandro Hinojosa	Centro de Investigación Científica y de Educación Superior de Ensenada
Joanne Kerbavaz	Tijuana River National Estuarine Research Reserve
Steve Morrison	National Oceanic and Atmospheric Administration, National Ocean Service
Tom LaPointe	National Oceanic and Atmospheric Administration, National Ocean Service
Bob Parrott	San Diego Association of Governments
Katie Ries	National Oceanic and Atmospheric Administration, National Ocean Service
Doug Stow	San Diego State University
Tim Trainor	U.S. Bureau of the Census
Alain Winckell	ORSTOM/El Colegio de la Frontera Norte
Richard Wright	San Diego State University

Appendix C

Identifying Priorities for a Geographic Imformation System (GIS) for the Tijuana River Watershed: Applications for Land Use Planning and Education

Agenda

Monday, November 28

5:00-6:00 p.m.
Organizational Meeting for Focus Group for Facilitators and Rapporteurs. *Bayview Room*

6:00-7:30
Reception. *Bayview Room*

Tuesday, November 29

8:00-8:30 a.m.
Registration. *Mission Bay Room*

8:30-8:45
Welcome
Karen Scarborough, San Diego Mayor's Office

8:45-9:15
Opening Remarks
Katie Ries, NOAA/NOS

9:15-9:45
Project Overview/Introduction to GIS
Gerardo Bocco, COLEF
Richard Wright, SDSU

9:45-10:25
GIS Case Studies:

Multiple Species Conservation Planning with GIS
Tom McDowell, Ogden Environmental

Environmental Planning for the Tijuana-Ensenada Coastal Zone
Lorenzo Gómez Morín, UABC

10:25-10:40
Coffee Break

10:40-12:00
GIS Case Studies (continued)

Use of GIS in Education
Mike Phoenix, ESRI

Estimation of Geological Risk Zoning in Tijuana, Using GIS
Alejandro Hinojosa, CICESE

The South Carolina Edisto River Basin GIS
Barry Beasley, South Carolina Department of Natural Resources

Man and the Biosphere Project
Kaare Kjos, Aqualink

12:00-1:30 p.m.
Lunch, *Bayview Room*

Orientation for Afternoon Sessions
Tom LaPointe, NOAA

1:30-3:30
Focus Group Sessions:

GIS Uses and Products for Environmental Planners. *Mission Bay Room*
Facilitator: Christopher Brown, SDSU
Rapporteur: Gerardo Chávez, CICESE

GIS Uses and Products for Urban Planners. *Executive Suites 702-704*
Facilitator: Laura Durazo, Ayuntamiento de Tijuana
Rapporteur: Mary Henry, SDSU

GIS Uses and Products for Educators. *Executive Suites 706-708*
Facilitator: Mike Phoenix, ESRI
Rapporteurs: Laura Martínez, ProEsteros, and Mike Wilken, CUNA

GIS Uses and Products for GIS Specialists. *Executive Suites 710-712*
Facilitator: Tom LaPointe, NOAA
Rapporteur: Andrea Westersund, SDSU

3:30-3:45
Coffee Break

3:45-4:45
Summaries of Group Sessions. *Mission Bay Room*

GIS and Environmental Planning
Chris Brown

GIS and Urban Planning
Laura Durazo

GIS and Education
Mike Phoenix

GIS for GIS specialists
Tom LaPointe

4:45-5:00
Closing Comments
Nina Garfield, NOAA

5:00
Adjournment

This workshop is funded and organized by the California Sea Grant College of the University of California, the National Ocean Service of the National Oceanic and Atmospheric Administration, the Institute for Regional Studies of the Californias at San Diego State University, and El Colegio de la Frontera Norte, Tijuana.

Appendix D

Identifying Priorities for a Geographic Information System (GIS) for the Tijuana River Watershed: Applications for Land Use Planning and Education Participant Questionnaire

1. Name _____

2. Profession _____

3. Position (briefly describe your responsibilities)

_____

_____

_____

4. What is the nature of your interest or involvement in the Tijuana River watershed and/or the United States/Mexico border area?

_____

5. What three educational and/or planning issues in the Tijuana River watershed do you think are most important?

_____

_____

_____

6. Do you believe that having access to a multidisciplinary database from which you can develop maps with information relevant to your work would facilitate you or your organization's agenda? Please explain.

_____

_____

_____

7. The following data are planned for inclusion in the Tijuana River watershed database. Indicate the importance of each for your uses by ranking each topic on the following preference scale: 5 = very useful, 4 = useful, 3 = moderately useful, 2 = slightly useful, and 1 = not useful.

___ Topography (land elevation)
___ Hydrography (streams/lakes/rivers)
___ Geology
___ Demography (population structure)
___ Economics/Business/Industry
___ Boundaries (political/jurisdictional)
___ Climate
___ Land Use (natural/urban/agriculture)
___ Land Cover (vegetation type)
___ Agriculture
___ Soils
___ Point Layers (sewage treatment plants, emergency response facilities, school, dump sites, etc...)

8. Please list any other types of data that would be useful to include in the GIS to further your agenda in the watershed or border area.

_____

_____

_____

_____

_____

9. What is your level of familiarity and/or understanding of Geographic Information System (GIS) capabilities and applicability to real-life problems? (1 = no understanding of GIS or its capabilities; 3 = Fully understand what a GIS is and its usefulness)

1 2 3

10. What is your level of experience with GIS technology? (1 = no experience with the technological aspects of designing and operating a GIS; 3 = very familiar with the technological aspects of GIS systems).

1 2 3

11. Please answer the following to the best of your ability:

a. What products would you like to obtain from the Tijuana River Watershed GIS to assist you in carrying out your interests in the watershed? (Check all that apply)

___ Thematic maps
___ Base maps
___ Graphs
___ Statistical tables
___ Digital data from the database for use with your GIS
___ Analysis making use of database
___ Processed digital data for use with user friendly software (e.g., ARCVIEW)

b. How often do you need these products?
__ Rarely (1 - 2 years)
___ Occasionally (monthly/quarterly)
___ Frequently (daily/weekly)

c. What level of detail of the data do you require?
___ Kilometer ___ 100 meters ___ 10 meters ____1 meter

d. What is the typical extent of area that you would examine?
___ Regional (watershed)
___ County (portion of watershed)
___ Community (small part of watershed)

e. What kind of computer system is used within your organization?

_____

f. What GIS software is (or will be) installed in your computer?

_____

_____

_____

12. Please add any other comments you believe would be helpful to thoses who are working on the Tijuana River Watershed Project.

_____

_____

_____

Appendix E

First Merged Products from the Tijuana River Watershed Project

The following three pages represent the first merged products from the Tijuana River Watershed Project. The integration has been accomplished on SUN SPARC hardware and a merge of data produced with ARC/INFO and SIG-SAVANE (ORSTOM) software.

1. Hydrography

   a. U.S. side: The data are derived from digitized blue line features on USGS 1:24,000-scale maps.

   b. Mexican side: The data are obtained by digitizing blue line features on INEGI 1:50,000-scale maps.

   c. Merged product: The merge is a combination of all blue line features on the USGS maps and feature levels 2 through 5 on the INEGI maps (level 1 was eliminated). The greater density of line symbols on the United States illustrates the difficulty of harmonizing digital data across the border. Including level 1 symbols from INEGI maps would have resulted in a higher density of line symbols on the Mexican side than on the U.S. side. Notice the numerous disconnected line segments. Most are also disconnected on the source maps but a few represent digital objects that require further editing.

2. Hypsometry

   a. U.S. side: The data are from USGS 1:24,000-scale DEMs with a resolution of 30 meters and elevation in feet.

   b. Mexican side: The data are obtained by digitizing lines at 10 and 20 meter intervals from INEGI 1:50,000-scale maps.

   c. Merged product: The merge is based on a classification of vector data into intervals of 100 meters.

3. Administrative Divisions

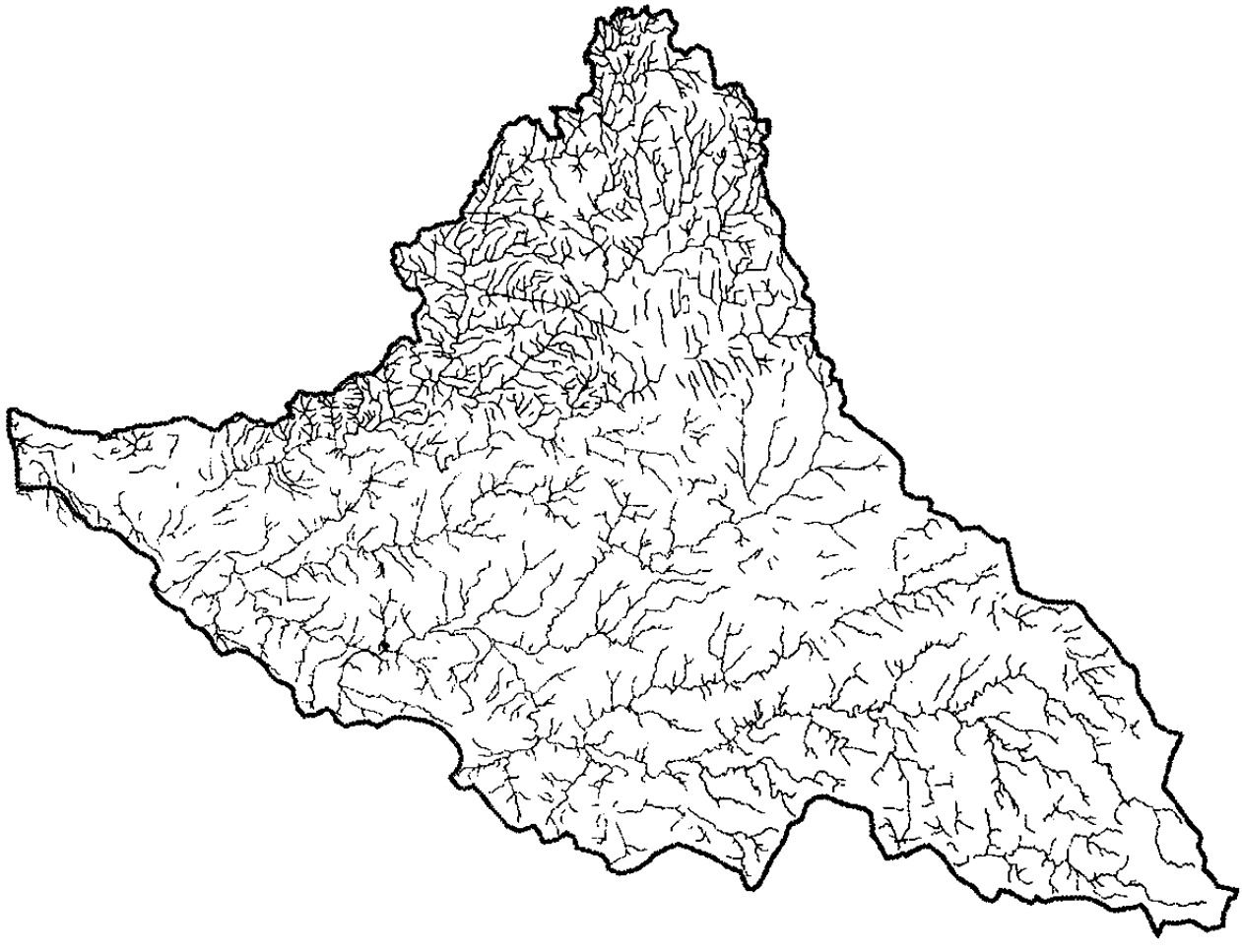
   a. U.S. side: The tract boundaries are obtained from U.S. Bureau of the Census digital files.

   b. Mexican side: The Areas Geoestadísticas Básicas (Basic Geostatistic Areas or AGEBs) are obtained by digitizing their boundaries from 1:50,000-scale maps.

   c. Merged product: The merge is a combination of the totality of the two files.

Hydrographic Network of the Tijuana River Watershed

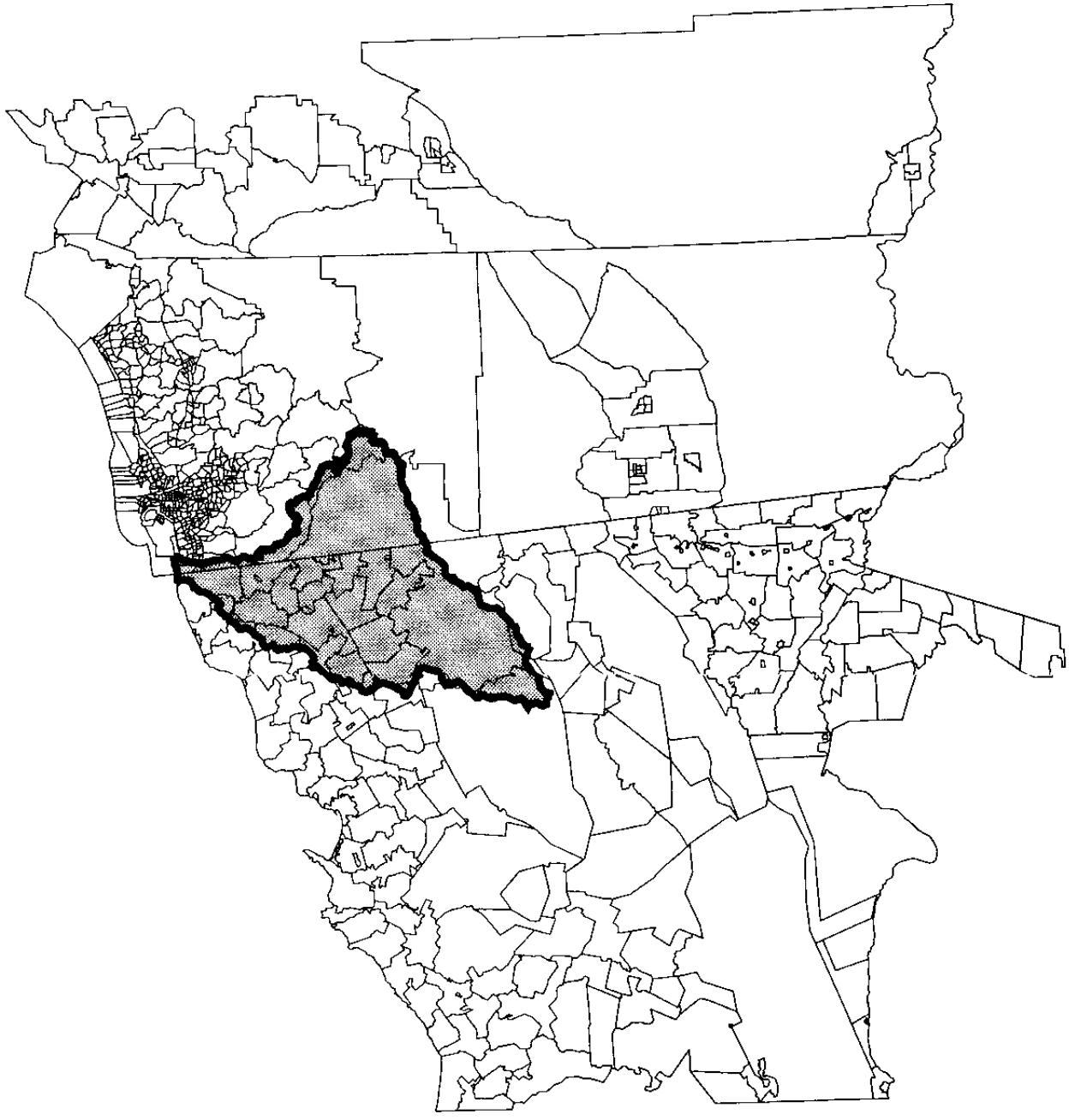
U.S.A.: All Blue line features selected
Mexico: Levels 2 to 5 selected



SIGEF/COLEF-ORSTOM, 1994

Administrative Divisions

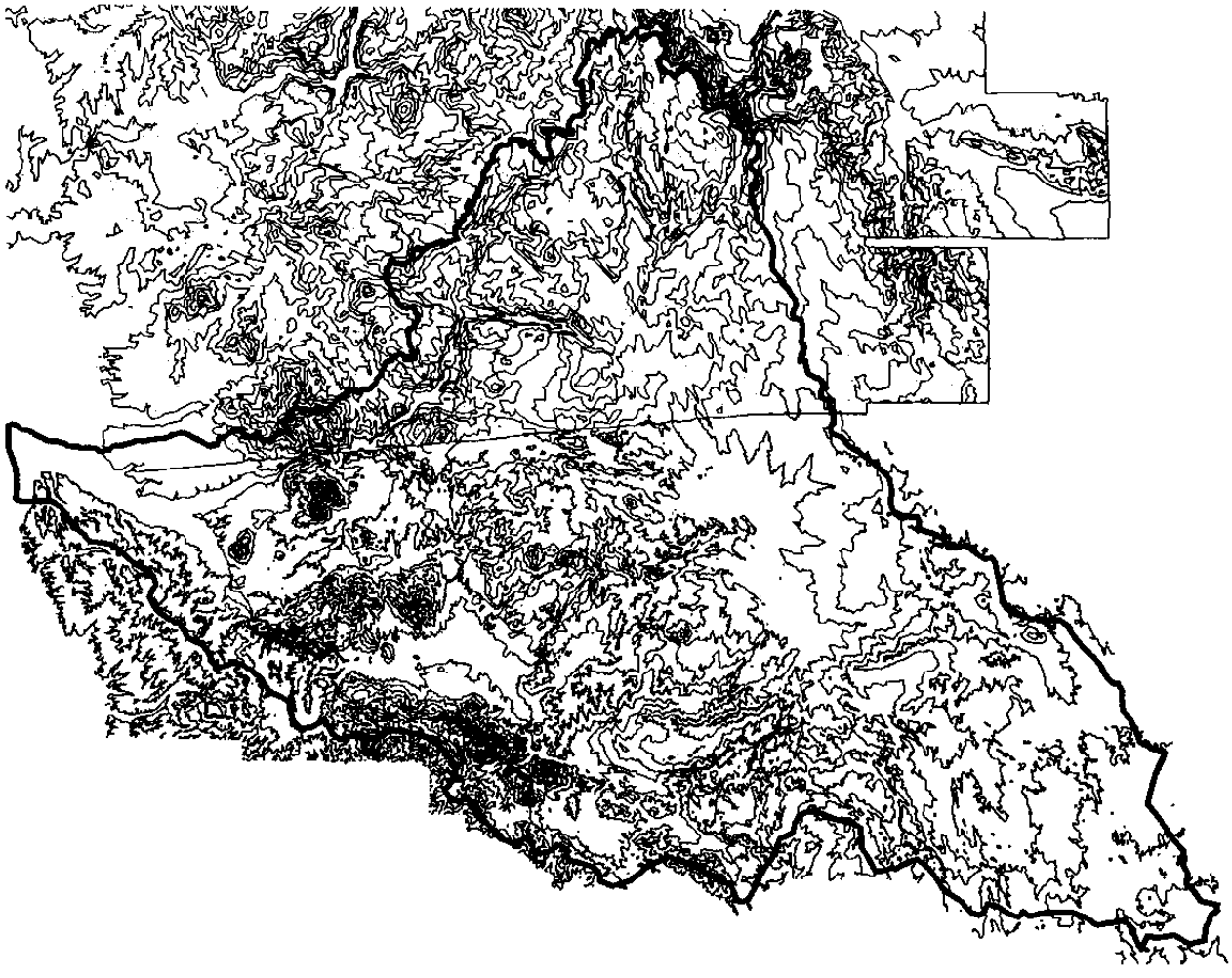
U.S.A.: Census Tracts
Mexico: AGEB (Basic Geostatistic Areas)



SIGEF/COLEF-ORSTOM, 1994

Hypsometry

U.S.A.: Vectorization of DEMs at 1:24,000 from USGS
Mexico: Digitizing of contours at 1:50,000 from INEGI maps
(Contour interval: 100 meters)



SIGEF/COLEF-ORSTOM, 1994

Appendix F

GIS POSTERS DISPLAYED AT THE WORKSHOP

The following list represents the author(s), affiliation, and title of posters displayed at the workshop.

1. David Askov
SDSU Department of Geography
Soils Mapping in the Tijuana River Watershed

2. David Askov, Fred Stutz, Stuart Aitken, Christa Stutz
SDSU Department of Geography
Freeway Alignment and Community Resident's Receptivity

3. Joe Babb
County of San Diego
County of San Diego General Plan

4. Joe Babb
County of San Diego
Emergency Fuel Storage

5. Joe Babb
County of San Diego
Palomar Mapping Area Vegetation

6. Joe Babb
County of San Diego
Tijuana River Watershed

7. Joe Babb
County of San Diego
Central Mountain Subregion Vegetation

8. Barbara Bell, Steve Dorner
SDSU Department of Geography
GIS Makes Search and Rescue Easier

9. Alice Brewster, Larry Deysher
Coastal Resources Associates
The Use of GIS for Wetlands Restoration

10. Matt Brown, Ross Miles
SDSU Department of Geography
San Diego County Soil Database Project

11. Sue Carnevale
SANDAG
Habitat Conservation Planning in the San Diego Region

12. Lisa Chaddock
SDSU Department of Geography
A Place to Gather: Kumeyaa and Yuman Spatial/Environmental Resource Use of Volcan Mountain

13. Tom Cook
Dudek & Associates
Natural Communities Conservation Program

14. Larry Deysher, Rick Ayens
Coastal Resources Associates
A GIS Analysis of Kelp Distribution in Southern California

15. Steve Dorner
SDSU Department of Geography
Environmental Data Layers of the Tijuana River Estuary

16. Janet Franklin
SDSU Department of Geography
Mapping Southern California Forests Using Remote Sensing and GIS

17. Andrew Hanes
Ogden Environmental
City of Poway Subarea Habitat Conservation Plan

18. Thomas Herman
SDSU Department of Geography
Children's Play and Geographic Behavior

19. Fred Mertz, Sally Westmoreland
Photon Research Associates, Inc.
A Foreign View of San Diego County

20. Stuart Phinn, Doug Stow, Joy Zedler
SDSU Department of Geography
Mapping Clapper Rail Habitat in Restored Marshes with Airborne Digital Imagery

21. David Shaari
SDSU Department of Geography
Remote Sensing of Restored Salt Marsh Vegetation

22. George Silva
Sweetwater Authority
Sweetwater Authority GIS Implementation

23. Peter Stine
U.S. Fish and Wildlife Service
Regional Coastal Sage Scrub Gnatcatcher Evaluation Model

24. Christa Stutz
SDSU Department of Geography
Cross Border Migration Flows

25. Debbie Turner
Ogden Environmental
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30. Alain Winckell, Michel LePage
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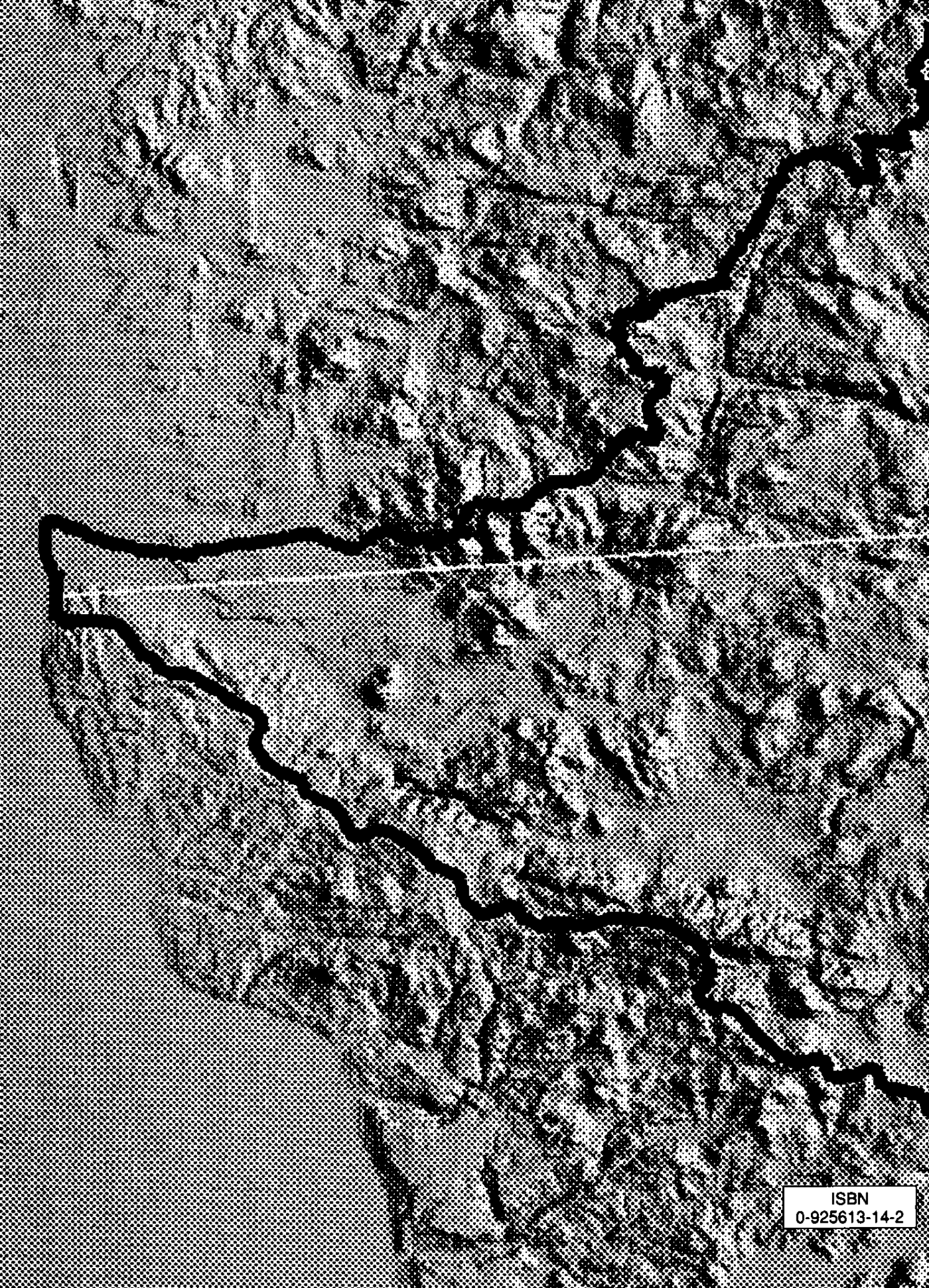

ISBN
0-925613-14-2