

United States-Mexico Transboundary Aerial Photography and Mapping Initiative

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Introduction

Mexico and the United States share a wealth of natural and cultural resources along their 3,250-kilometre international boundary. The border region overlies a vast area of diverse landscapes and cultures, contrasting some of North America's most pristine and untouched ecosystems with some of its fastest growing urban areas. This region encompasses a wide array of physical settings and habitats, including freshwater and marine wetlands, deserts, rangelands, mountains, and forests, that are unique in terms of the diversity of their water, mineral, and biological resources.

Politically, the border area includes four States in the United States (California, Arizona, New Mexico, and Texas) and six States in Mexico (Baja California Norte, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas). There are 14 major sister-city pairs along the border, and the 200-kilometre-wide border region is home to more than 10 million people, a tenfold increase during the past 60 years. The socio-political culture that has developed in the region is truly unique, and the natural resource and environmental issues freely affect the entire area.

A wide array of federal, state, local, and tribal entities in both countries are responsible for the management of the border's natural and cultural transboundary resources. Among these valued resources are (1) numerous national monuments, forests, and wildlife refuges; (2) biosphere reserves; (3) several state and national parks; (4) a national seashore; and (5) a designated wild and scenic river.

Within the U.S. part of the border region, the U.S. Federal Government owns or administers approximately 45 percent of the land, most of which is managed by the Department of the Interior (DOI). A large proportion of the remainder is owned or managed by state, local, and tribal authorities. In Mexico, large areas are being designated for Federal protection and management. Even as the governments are setting aside lands for protection, the existing parks and refuges continue to face a variety of issues, such as (1) limited water supply and altered water flow patterns; (2) point source pollution discharges (municipal and industrial); (3) nonpoint source pollution (mining, urban and agricultural runoff, irrigation return flows, untreated human waste, septic systems, and atmospheric deposition of contaminants from industrial, power-generation, and urban sources); and (4) overgrazing by trespassing livestock.

In response to these problems, DOI agencies have identified relevant crosscutting natural resource and land management issues. DOI Bureau representatives are addressing these issues by working together with Mexico as the DOI United States-Mexico Field Coordinating Committee (FCC). The FCC was established in 1994, and its charter was signed by a coalition of nine DOI Bureaus. The primary goals for the FCC are

to work with its counterparts in Mexico and to facilitate the development of consistent and coordinated DOI policies, strategies, plans, and program priorities, while addressing the natural resource, environmental, and cultural concerns of the border region.

Despite the historical and present-day importance of the border region, there are gaps in scientific information regarding the extent and abundance of its natural resources and the delineation of its physical setting. Scientists and land managers representing both countries need current, accurate, and binationally compatible geospatial information to deal with such issues as water pollution, water availability, air pollution, biological resources, and human health. The U.S. Geological Survey (USGS), as the DOI science bureau, is working in a variety of forums to set in place the mechanisms to provide basic geographic information system foundations for natural resource, environmental, and land-management studies. Specifically, the USGS National Mapping Division (NMD) is actively responding to the governmental and public need for geospatial data to facilitate the management of the numerous issues in the border region. Current and consistent binational geospatial data required to develop effective and appropriate strategies for addressing these issues are just now becoming available as a result of the USGS leadership role in the U.S.-Mexico Border Region, Transboundary Aerial Photography and Mapping Initiative.

Aerial Photography Initiative

On 06 May 1996, during the 13th annual meeting of the U.S.-Mexico Binational Commission (BNC) in Mexico City, the two countries signed an agreement to undertake an ambitious aerial photographic survey along the entire 3,250-kilometre-long and 200-kilometre-wide border region. This agreement was the result of nearly 2 years of negotiations between the United States and Mexico.

As a result of this binational agreement, and through funding partnerships with federal and state agencies, the USGS has completed the acquisition of 1:40,000-scale color-infrared (CIR) photographic images for the entire (2,581-quad-angle) U.S. part of the border region (Figure 1). Financial support for this CIR aerial photography came as a result of USGS funding and partnerships with the following contributors: Environmental Protection Agency; International Boundary and Water Commission; DOI Office of the Assistant Secretary for Policy, Management and Budget; and the State of Texas. These CIR aerial photographs are now available for purchase through USGS Earth Science Information Centers and at the following Internet address:

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and Remote Sensing

U.S. Geological Survey, Mapping Division, Box 25046, Bldg.
810, MS-507, Denver Federal Center, Denver, CO 80225
(kjosborn@igsdn009. CR.USGS.GOV).

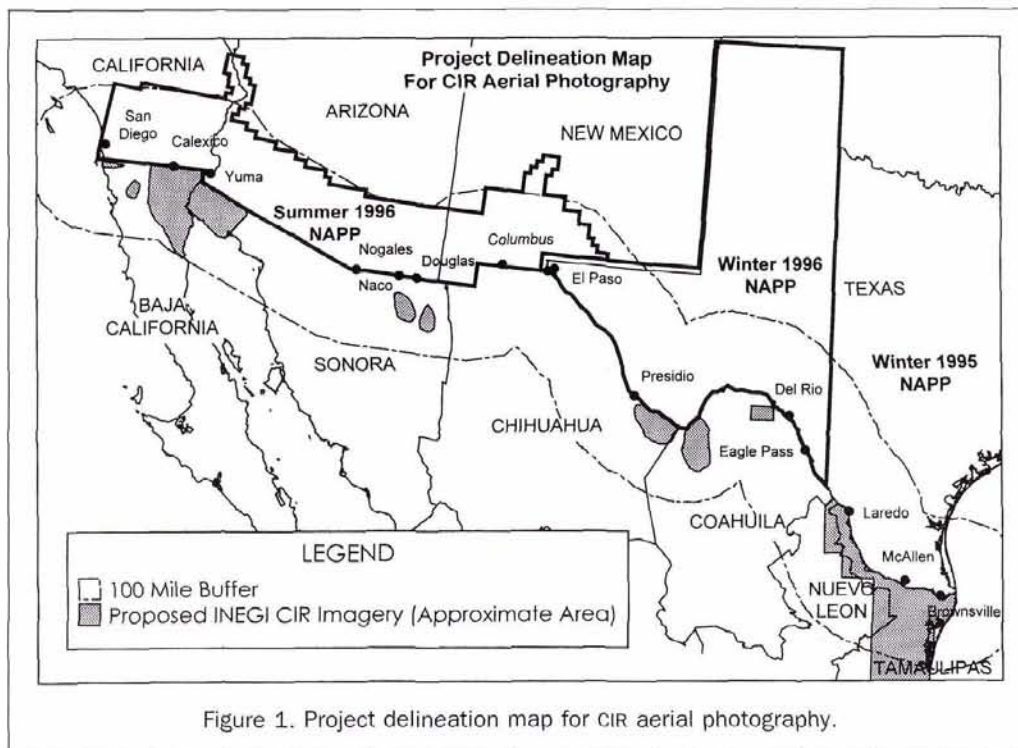


Figure 1. Project delineation map for CIR aerial photography.

<http://edcwww.cr.usgs.gov/webglis>.

Similarly, Mexico's mapping agency, Instituto Nacional de Estadística, Geografía e Informática (INEGI), has planned to take and is acquiring similar aerial photographs for the Mexican side of the border. INEGI's photographic survey includes the acquisition of 1:40,000-scale CIR images for natural resource and environmental studies in protected areas that are defined as environmentally sensitive, and 1:75,000-scale black-and-white images in their nonpriority areas. Availability and purchase information regarding INEGI's photographs can be obtained through their sales office in Aguascalientes, Mexico. The INEGI sales office address is as follows:

INEGI - Centro de Informacion
 Av. Heroe de Nacozari 2301 Sur
 Fracc. Jardines del Parque, CP 20270
 Aguascalientes, Ags, Mexico

These color-infrared and black-and-white photographs from the USGS and INEGI yield a wealth of information and data about the land, water, surface vegetation cover, and natural resources of the border region. For instance, these images can be used to support water resource studies, water quality assessment, ecosystem and habitat management, environmental surveys, agriculture and forestry issues, and land-use studies. These photographs also serve as the foundation for the USGS and INEGI border mapping program.

Digital Geospatial Data Collection Activities

The USGS has worked closely with the FCC representatives and with the DOI Geographic Data Committee's Base Mapping Working Group to establish the border region as a high priority area for mapping needs. As a result of this designation, funding was allocated in fiscal years 1996-99 for developing new and revised digital geospatial data.

Until the U.S.-Mexico Transboundary Mapping Initiative, there were no compatible or recent maps (analog or digital) of the border region. As our countries are being challenged to demonstrate that economic and industrial development

can coexist within a healthy environment, accurate maps and digital geospatial data products are proving to be essential planning and modeling tools. In essence, our two governments recognize that certain types of base geospatial information serve as fundamental elements on which others can build. To this end, the United States and Mexico are developing compatible geospatial data standards for use in binational geographic information system (GIS) applications.

In 1996, while new photographs were being acquired, the USGS began mapping efforts for data categories where the new photographs would not be used. Border mapping startup efforts were made possible because of the USGS-funded and coordinated DOI High Priority Digital Data Program. As a result of funding received through this program, the USGS, in partnership with private industry, began and completed the production of all border region 1:24,000-scale digital elevation models (DEM), digital raster graphics (DRG), public land survey system (PLSS), and boundary digital data files. These digital geospatial data are now available for ordering through USGS Earth Science Information Centers and at the following Internet address:

<http://mapping.usgs.gov/www/products/1product.html>

Color-Infrared Digital Orthophotography and Digital Revision Mapping

Beginning in fiscal year 1997, and using the newly acquired CIR imagery, the USGS initiated private industry partnerships to begin the production of 1:12,000-scale CIR digital orthophoto quadrangles (DOQ) for the U.S. portion of the border region. To date, DOQs for approximately one-half of the U.S. border area are being produced. Public availability of these initial quadrangles was realized in June 1998 (Figure 2). Completion timeframes for the remaining border region DOQs are being scheduled on a priority basis, with the lowest priority quadrangles to be completed by the year 2001 (based on available funding). Information pertaining to DOQ availability and ordering information can be obtained through

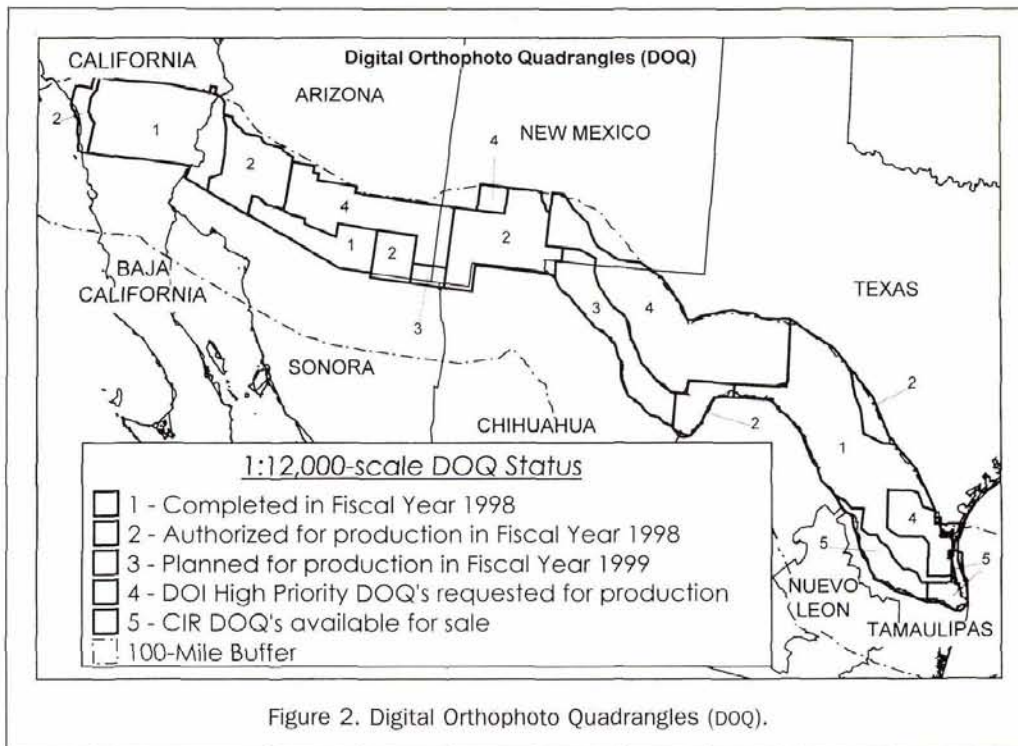


Figure 2. Digital Orthophoto Quadrangles (DOQ).

USGS Earth Science Information Centers and by using the following Internet address:

<http://edcwww.cr.usgs.gov/glis/glis.html>.

As DOQs become available, the USGS will use them to start updating and revising the transportation and hydrography vector data themes. DOQs are used in the data compilation process because they combine the image characteristics of an aerial photograph with the geometric qualities of a map. The DOQs serve as the primary source for geographic data and as the foundation for 1:24,000-scale USGS digital mapping and revision efforts. They can also be used in geographic information systems as the georeferenced photographic image base layer, or foundation, from which other thematic data layers and information can be referenced.

The timeframes for collecting and revising the transportation and hydrography vector data themes and producing the subsequent updated graphic maps will largely depend on funding availability. However, for planning purposes, a goal of 2005 has been established for completion of all USGS supported digital data themes for the 2,581 7.5-minute quadrangles considered to be in the U.S. part of the border region.

USGS and INEGI Cooperation

For the first time in history, the U.S. and Mexico mapping efforts are being coordinated and designed to be compatible so that important geographic data can be understood in a common framework on both sides of the border. The USGS and INEGI cooperated on the El Paso/Ciudad Juarez pilot project to develop processes and data attribute crosswalks for integrating digital data between the two countries. The result of this pilot project is that the USGS and INEGI successfully collaborated on developing software that translates and converts INEGI's digital data features and data themes into theme-separated digital line graphs (DLG). Because this pilot project was a success, the USGS and INEGI now have the technical ability to integrate and use each other's digital geospatial data for GIS applications. However, differences remain with

regard to the standards for data content, accuracy, and scale. Technical experts from the USGS and INEGI continue working together to understand and resolve these differences.

The USGS and INEGI partnership continues to grow as a new binational agreement for data sharing is now being written. As the USGS and INEGI plan and accomplish border region mapping projects, it is extremely important that geographic information be shared across the border so that our maps will join and fit each other at their edges. This is a very important issue because a major goal of the mapping initiative is to ensure that our countries have binationally consistent and seamless base mapping information for use in numerous GIS applications. To accomplish this, the USGS and INEGI are now involved in program planning and technical standards meetings.

Summary

Historically, the border region has been benignly neglected, resulting in a lack of basic infrastructure. The current population of 10 million people is expected to double in the next 20 years. This growing population will present ever-increasing demands on the environment and on the very limited natural resources. Of particular concern is the diminished availability of clean water, which threatens the diversity and abundance of the area's biological and natural resources. To study the effects of these changes, the two countries must develop compatible geographic information systems that characterize the landscape and describe the resources of the transboundary region. This information is critical to help citizens, local and state governments, DOI bureaus, and other federal agencies make informed decisions concerning land and water management, environmental protection, and ecological preservation within those areas. Some specific project applications will include the hydrological and ecosystem studies of the Lower Rio Grande valley watershed of Texas and Tamaulipas, Mexico, restoration of desert riparian vegetation in the Santa Cruz River area in Arizona and Sonora, Mexico, and determination of the levels of toxic pollutants in

the Lower Colorado-New River toxics survey. Other applications include water quality monitoring, International Boundary and Water Commission mapping support, and Lower Rio Grande mapping projects.

As the lead federal agency for civilian mapping, the USGS must ensure that the Nation's needs for basic geospatial data are met. The USGS is also obligated to ensure that agencies coordinate activities with respect to basic geospatial data. Government agencies, private industry, nonprofit organizations, and private citizens will use these new maps, digital geospatial data, and binationally compatible geographic information systems to make informed decisions concerning land and water management, environmental protection, and

ecological preservation along the U.S.- Mexico Transboundary Region.

Acknowledgments

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Forthcoming Articles

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Michel Boulianne and Clément Nolette, Virtual Reality Applied to User Interfaces for Digital Photogrammetric Workstations.

Daniel G. Brown and Alan F. Arbogast, Digital Photogrammetric Change Analysis as Applied to Active Coastal Dunes in Michigan.

Giles M. Foody, The Continuum of Classification Fuzziness in Thematic Mapping.

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