

**CREATING A SINGLE MAP
REGIONAL GEOGRAPHIC INFORMATION SYSTEM TO SUPPORT
WATER PLANNING IN THE PASO DEL NORTE REGION**

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PURPOSE

A majority of the maps, both hardcopy and digital based, available for water planning in the Paso del Norte region, whether produced by the United States of America or the United States of Mexico, has the typical “blank” area on the other side of the International Border. This is also true to a lesser extent for maps of Texas and New Mexico. In most cases, the information is available, but the basic layers are at different spatial scale, resolution, and extent. This at times has precluded their combined use. The purpose of this project was to remove the “blank” area across the International Border by developing and creating a regional geographic information system (GIS) to support regional water planning in the Paso del Norte area.

INTRODUCTION

On February 23, 2001, the Paso del Norte Water Task Force held its first planning workshop at the El Paso Community Foundation in El Paso, Texas. The workshop was attended by 10 Task Force members, 13 Task Force Support Team members, and 30 invited water experts, professionals and community leaders.

The purpose of the first Paso del Norte Water Task Force Planning Workshop was to open a discussion on how to improve cooperative water planning among water entities in the Paso del Norte. Central to the discussion were two areas of possible cooperation: policies and projects. Cooperative policy aspects include how water plans are made and carried out, how water rights are transferred, and how water entities work together to manage common resources. Cooperative projects could include joint water conservation projects, water quality testing, or building a regional database of land use information. In advance of the workshop, participants were given a preliminary list of policy and project options under consideration, generated through exploratory discussion among Task Force members, and asked to think about the challenge set forth. The workshop generated important information for the Task Force and the citizens of the Paso del Norte by collecting ideas for cooperative water policies and projects for the Paso del Norte, proposing short-term actions to achieve long-term goals, and finding a sense of agreement about priorities for action. The results from the workshop formed recommendations and proposals for action.

One of the action items identified by the workshop was the need for a bi-national mapping effort that could overcome the “blank-map” problem that many of the water planning groups had encountered. The Task Force encouraged technical experts to investigate how the problem might be solved and prepare a workplan and proposal that the Task Force might pursue.

A technical team consisting of GIS experts at the three universities was formed and a proposal was developed. The proposal was submitted for consideration by the William and Flora Hewlett Foundation, which had supported other efforts of the Task Force. The project was favorably received by the Foundation and the project was initiated June 1, 2001.

The cooperating experts in the Geographic Information System (GIS) Centers of the New Mexico Water Resources Research Institute, New Mexico State University, Pan-American Center for Earth and Environmental Sciences, University of Texas El Paso, and the Centro de Información Geográfica, Universidad Autónoma de Ciudad Juárez undertook the project. These professionals had available to them a number of resources and talents, including critical components of data, hardware, software, and support staff.

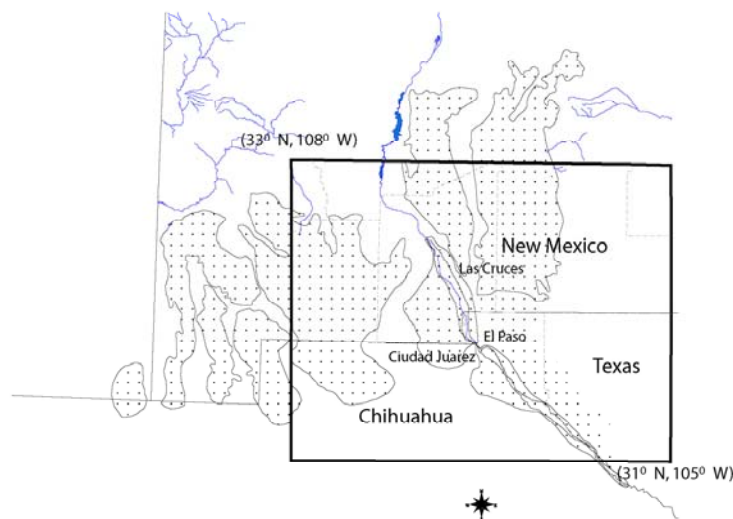
OBJECTIVE

The objective of the project was to create a seamless GIS for the Paso del Norte region. This required the establishment of a working relationship of the team.

MAP AREA

An initial component of the project was the determination of the area that would be included or “map extent.” The area of focus of the Task Force has generally encompassed the area below Elephant Butte Reservoir in New Mexico to Fort Quitman, Texas. The project team selected the map extent shown in the figure below to guide the data acquisition, data development, and map products.

The area extends from 33° North latitude 108° West longitude to 31° North latitude 105° West longitude. Some map products may extend beyond the area.



METHODS

A major task of the project was to acquire and evaluate existing digital data useful to water planning activities with a goal of combining them into seamless products. Where digital data were not available, tasks were designed to assess requirements for their development.

In addition, other databases that would be useful for regional water planning efforts were

identified. Examples include groundwater aquifer boundaries, public water well locations, watershed boundaries, and landuse classifications. Project team members worked closely with regional planners to identify and incorporate as many of these items as possible. As the draft combined products were developed, they were shared with each of the participating units for review. Also, a number of presentations were made at various forums to inform interested groups, organizations, and agencies of the project and products. This provided useful feedback to the project team. One identified item was the usefulness of the procedures developed in this project to other border areas and the importance of documentation of the processes and techniques utilized. Another, was the vision that a map resulting from this project could become a portal for the delivery of all types of digital data such as streamflow records, water quality measurement information, and others. Both of these items influenced the process and products.

The respective teams utilized an array of GIS software to process the information. A general description or overview of the techniques and software used is included in the following sections where appropriate. The combined data products were designed to be utilized with the ESRI ArcInfo®, ArcView®, ArcGIS®, ArcMap®, and ArcExplorer® as well as other compatible software products. Detail is included in “presentation” format on the enclosed CDROM.

FRAMEWORK BASEMAP DATA

The basic geographic spatial databases, also known as framework or basemap data, consist of seven components. These are: geodetic control, orthoimagery, elevation, transportation, hydrography, governmental units, and cadastral information. The geodetic component consists of a database of geographic points, with surveyed location and elevation. These points can be used as control points for other spatial databases. The orthoimagery component consists primarily of aerial photography that can be used as a source of information or as a backdrop to other databases. The elevation component consists of two data types. The first data type is called a digital elevation model (DEM) and consists of a database that has a regular grid or lattice of points with elevation information tied to each point. When viewed in a GIS software package such as ArcView®, this data type has the appearance of a continuous undulating surface. The second data type consists of regular interval contours that represent elevation data within a DEM. The transportation component consists of linear data that represent the transportation networks. The hydrography component represents surface-water features, such as streams, rivers, lakes, and playas. The governmental units component represents boundaries such as county/state lines and municipal jurisdictions. The cadastral component represents the ownership or control of land parcels. Metadata was acquired or developed for all spatial components following the FGDC standards.

DATA DICTIONARY

The data dictionary describes, in detail, the data contents of a database, with emphasize on providing explanations of categories. The data dictionary developed for most of the spatial components included is contained in the Appendix on the CDROM.

PRODUCTS

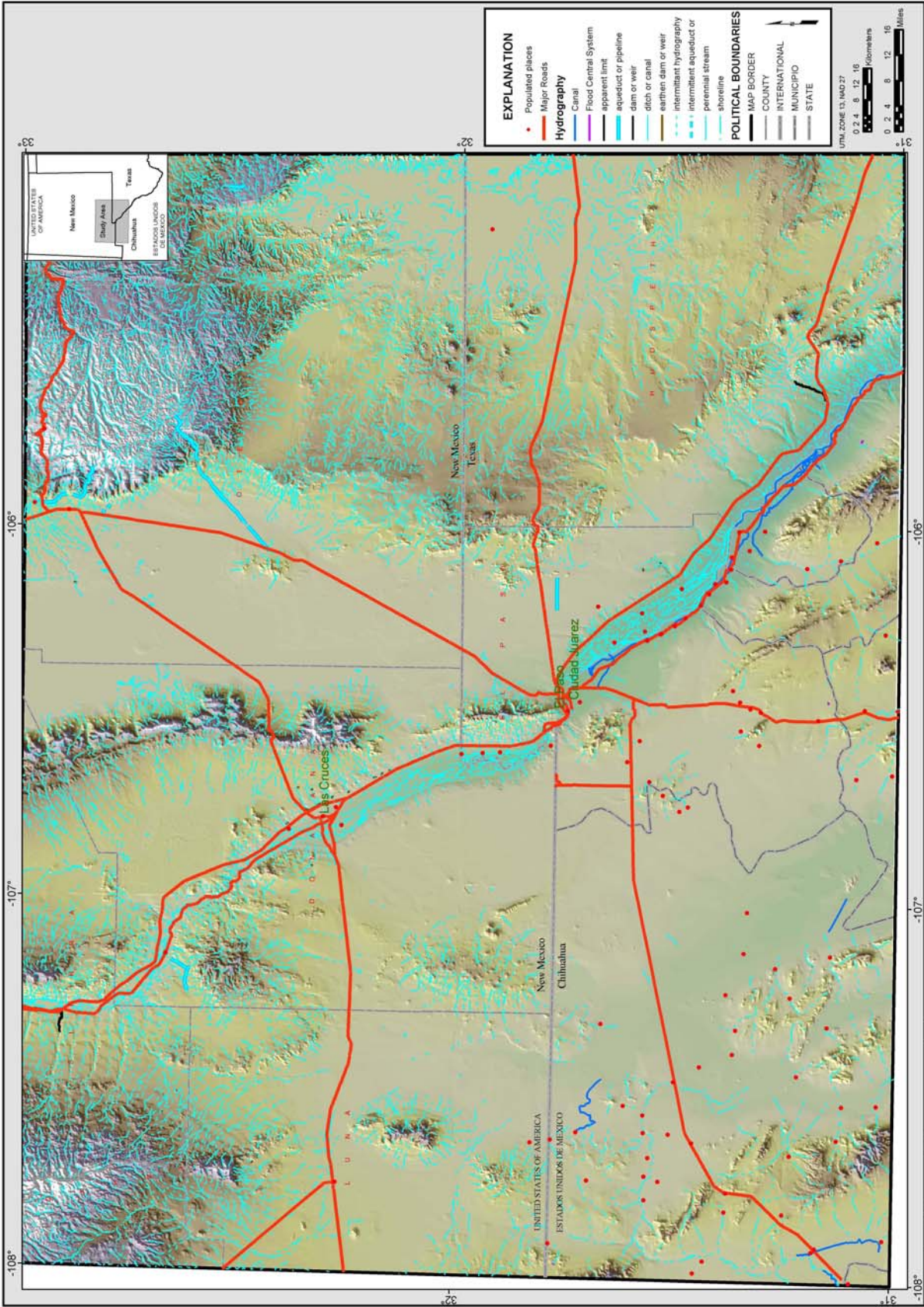
The products of the effort are three-fold. First, the map components or themes for both the basemap and additional map items along with their respective metadata are contained in the **GIS** folder on the included CDROM. Second, detail listings of processing steps, views, and discussion points are presented in the **PROCESS** folder on the CDROM. Third, copies of the example map compositions presented on the following pages that were developed utilizing the map themes are also included in jpeg format in the **EXAMPLE** folder on the CDROM. Also included in the EXAMPLE folder is the ArcExplorer® software that can be used to display the information.

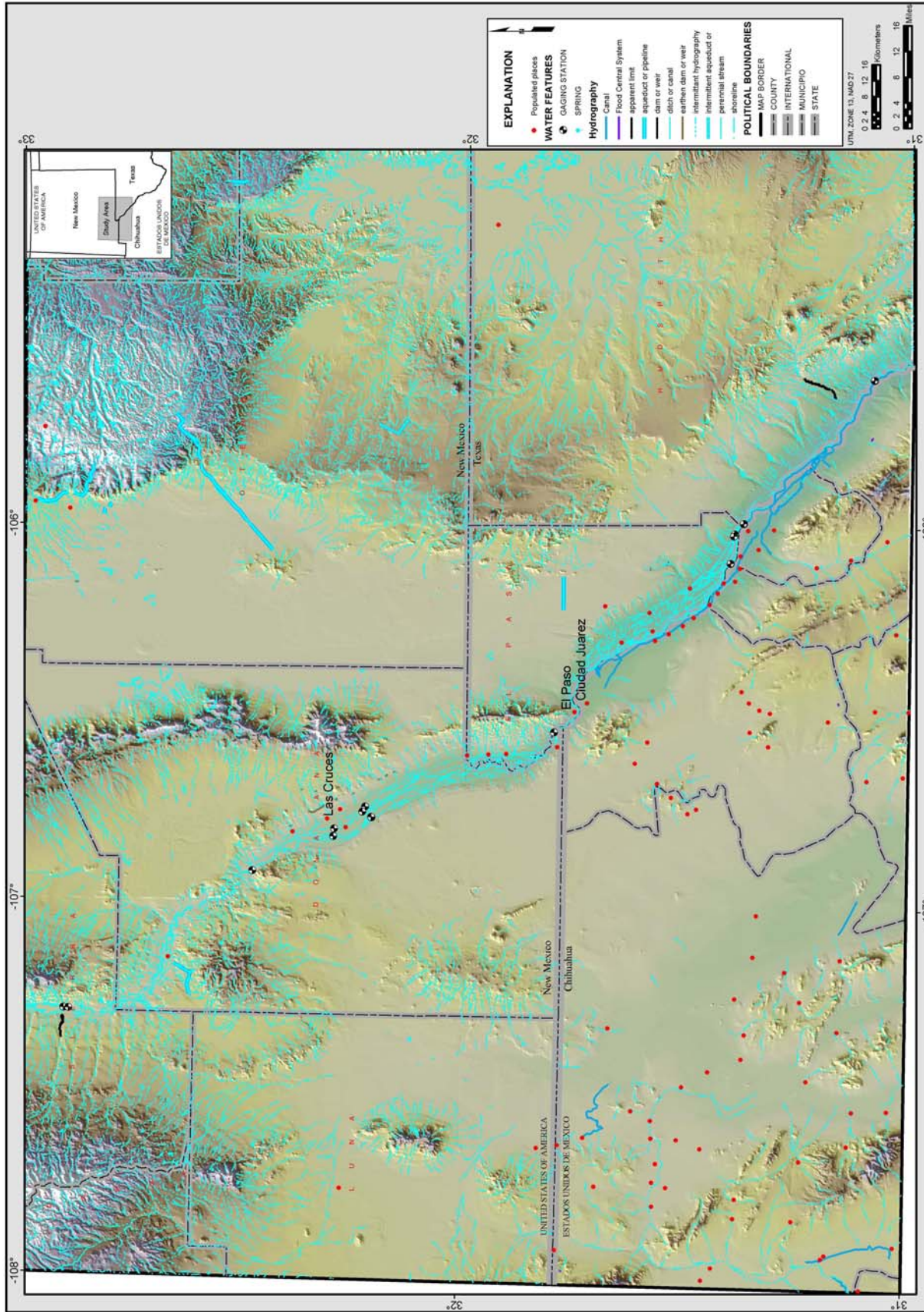
Map 1 combines four out of the seven framework or basemap datasets into a single map. The map utilizes the elevation (DEM) theme displayed as general relief as a background combined with the transportation, hydrography, and governmental units theme. The illustration of the transportation theme on this map is restricted to the major roads, however, the complete basemap can be seen on Plate 1 included in jpeg and pdf format in the EXAMPLE folder on the CDROM. The orthoimagery and geodetic control datasets are supplementary information and are not included on these maps. However, the geodetic control points and some of the available orthoimagery datasets are included on the CDROM.

The basemap datasets were created either by processing of digital datasets from the USGS or by digitizing hardcopy maps published by other federal mapping agencies. Mexico's major data sources included official digital coverage's from INEGI (National Institute of Statistics, Geography and Information) on both digital and analogical formats. Many additional display combinations are possible utilizing the themes that have been developed and included.

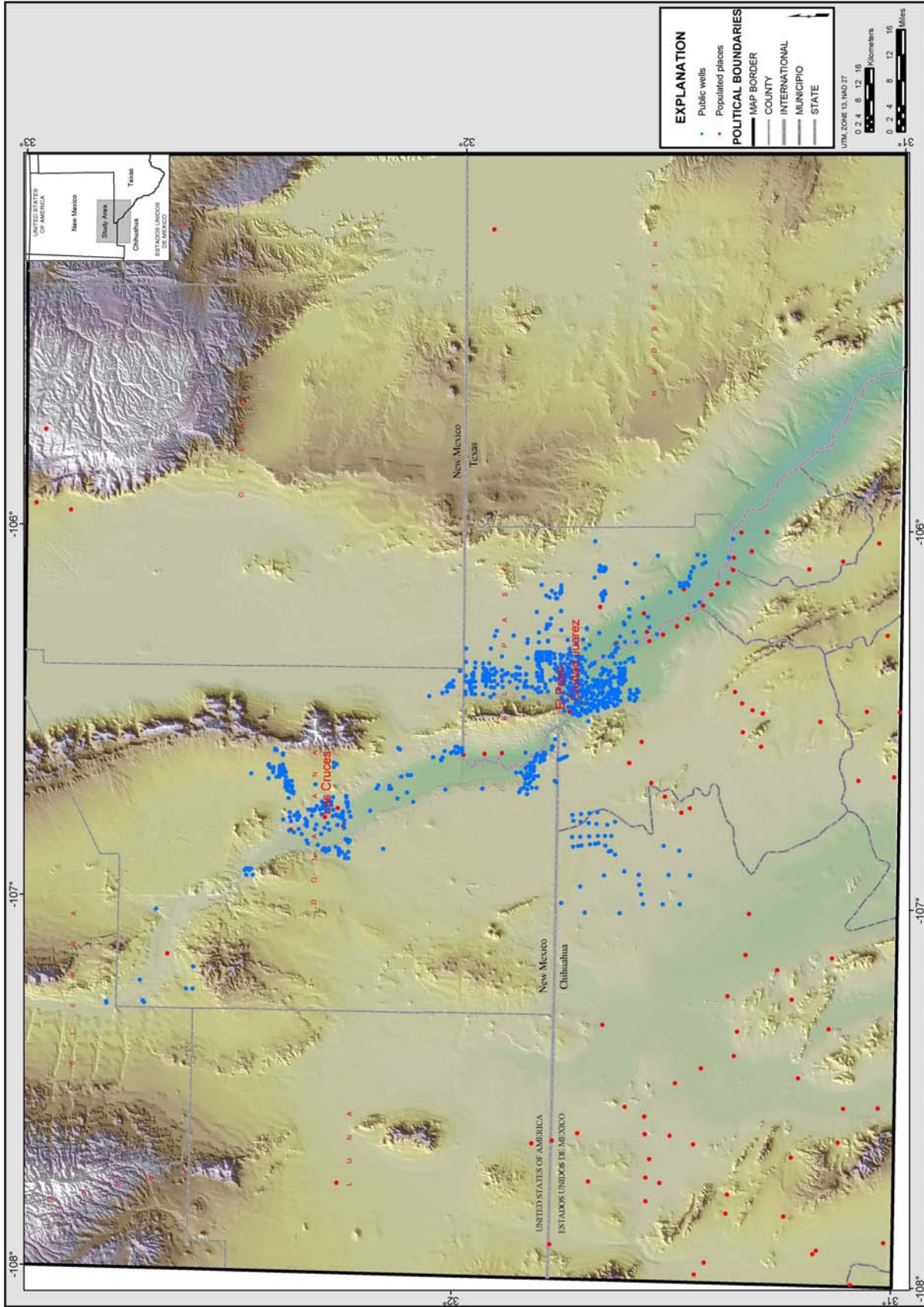
Map 2 removes the transportation theme and adds the USGS gaging station locations as a point theme that overlies hydrography theme. These locations represent sampling sites for surface water quantity and quality. Stream flow measurements and water chemistry information are available for analysis from these sites. Although water quantity and quality information was not included on the CDROM, these data are available from various sources.

Map 3 retains the shaded relief and boundaries and adds the point locations that represent public water wells in the region. The well locations included in this dataset are limited to public water supply wells in Dona Ana County, wells operated by El Paso Water Utility, and wells operated by the Junta Municipal de Agua y Saneamiento of Ciudad Juarez.





Map 2. Surface water features (Hydrography) and USGS gaging stations.



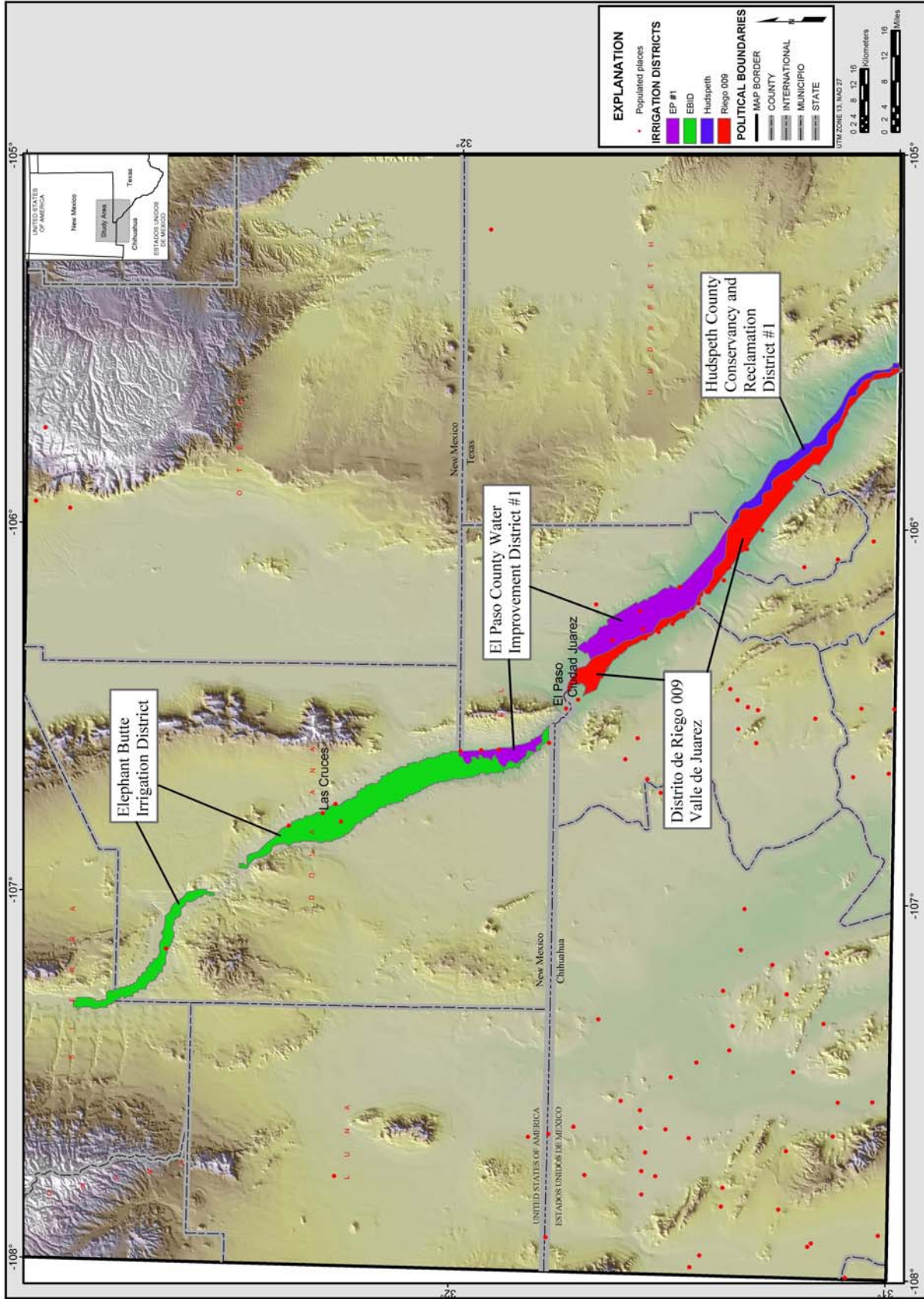
Map 4 illustrates the geographic extent of the three irrigation districts in the region. Elephant Butte Irrigation District is located in New Mexico and has an aerial extent of about 90,000 acres (36,400 hectares). The El Paso County Water Improvement District #1 is located in El Paso County, Texas and has an aerial extent of about 69,000 acres (27,900 hectares). The Hudspeth County Conservancy and Reclamation District #1 is located in Hudspeth County, Texas and has an aerial extent of about 15,000 acres (42,500 hectares). The Distrito de Riego 009, Valle de Juarez is located in northeastern part of the state of Chihuahua, Mexico and has aerial extent of about 39,700 acres (16,000 hectares).

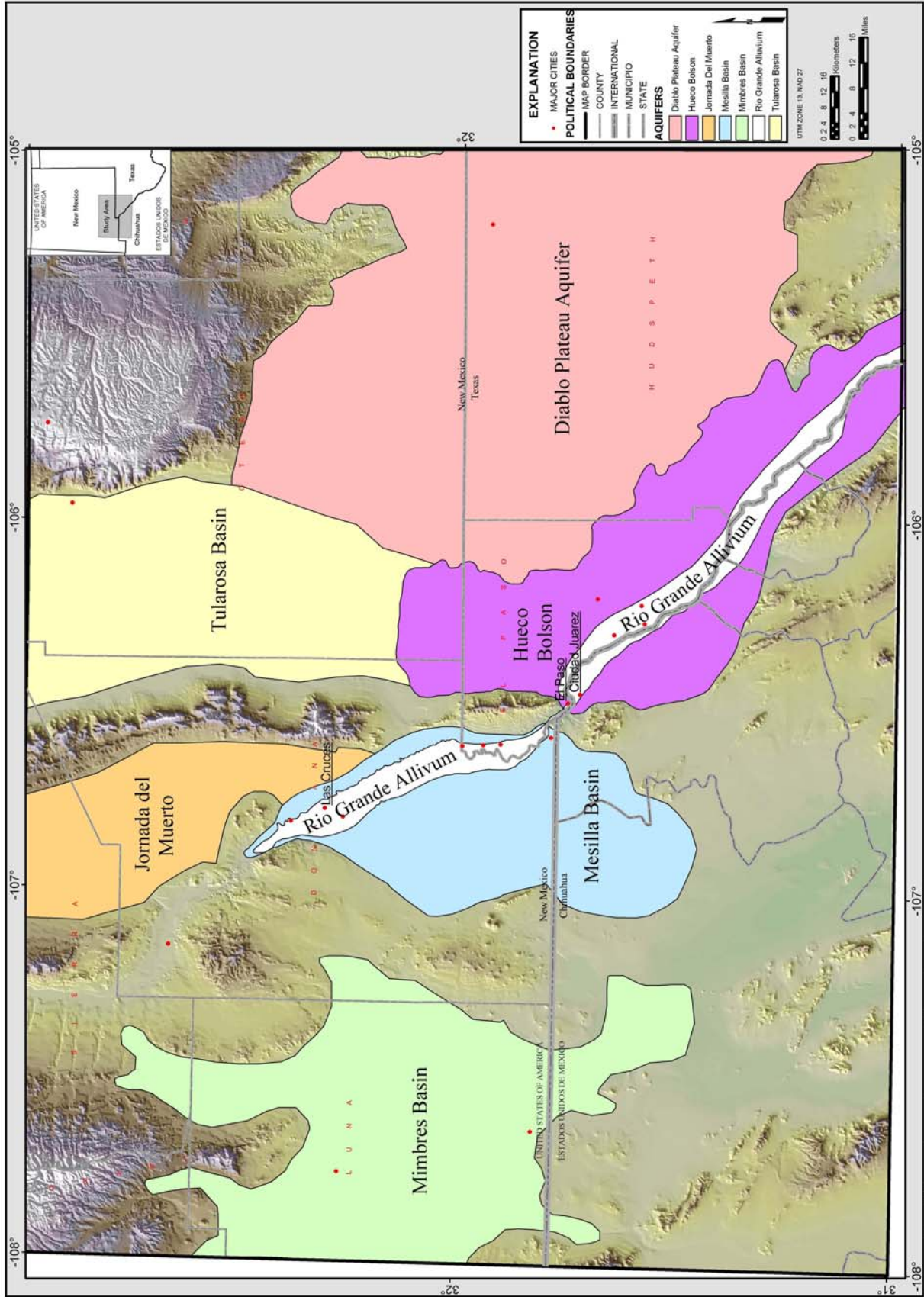
Map 5 shows the extent of the major groundwater aquifer systems in the region. This map is intended to provide a general orientation of the major aquifers in the region. The boundaries of these aquifers are not precise and are under continued investigation. The primary source of information on these aquifers is the reports entitled *Transboundary Aquifers of the El Paso/Ciudad Juarez/Las Cruces Region* (Hibbs et al., 1997) and *Trans-International Boundary Aquifers of Southwestern New Mexico* (Hawley et al., 2000).

Map 6 displays the land use of the region combined with other relevant themes (governmental units – international boundary, state boundaries, county boundaries, municipalities and towns). The land use data set describes the vegetation, water, natural surface, and cultural features of the land surface. The data on the US side was acquired from the USGS and is a part of the National Mapping Program. The data set is best used for 1:250,000-scale representation of the Anderson et al. (1976) land use and land cover classification. The data on the Mexico side, which also uses the Anderson et al. (1976) classification, was derived from the published Carta Uso del Suelo y Vegetacion map at a scale of 1:250,000.

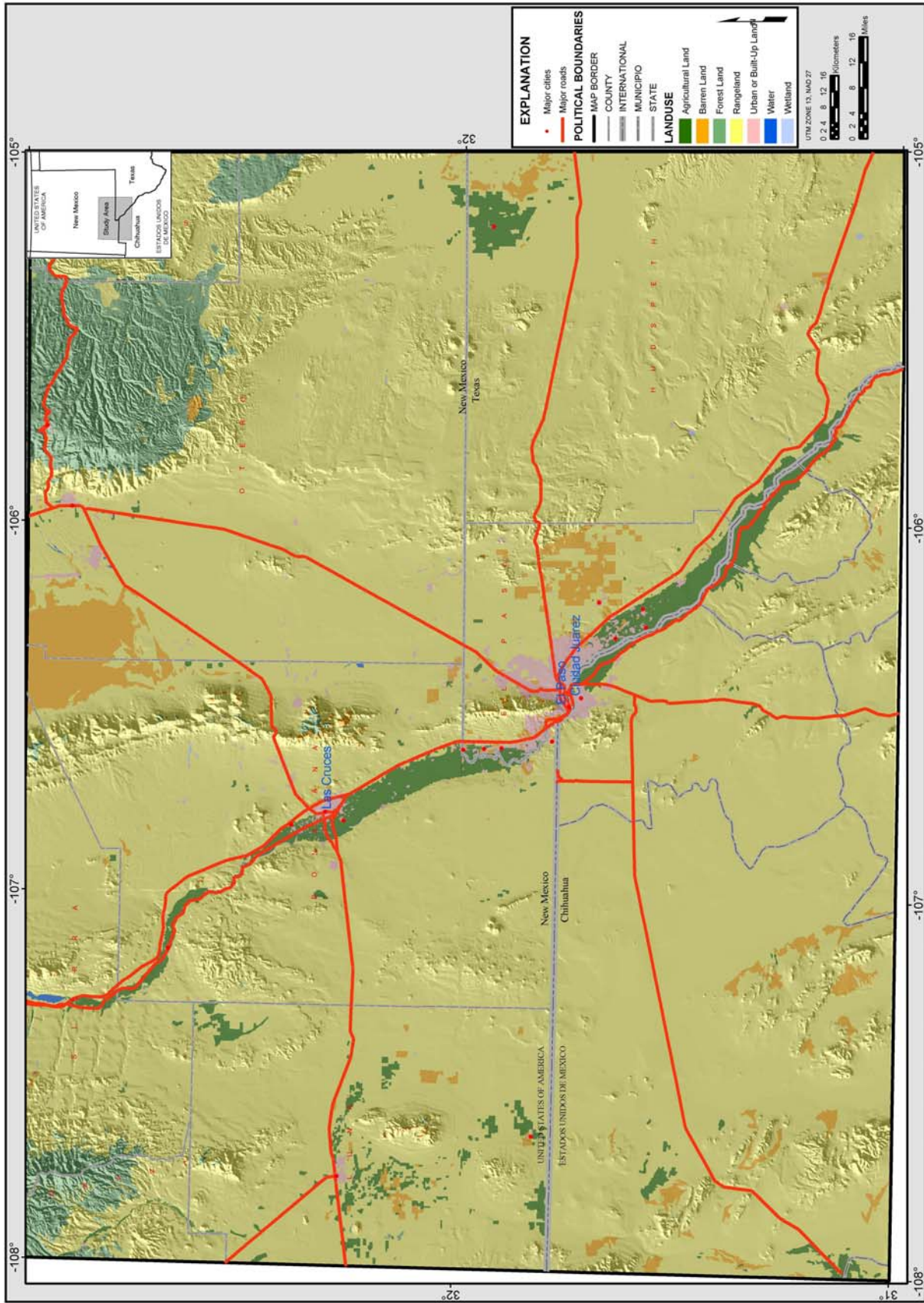
The land use theme was compared to more recent aerial photography and LANDSAT 7 imagery datasets and was found to be out-of-date. The areas that are classified as urban have grown significantly since the publication of the maps that these data are based upon. An update to this dataset is necessary and can significant help in the regional water planning efforts.

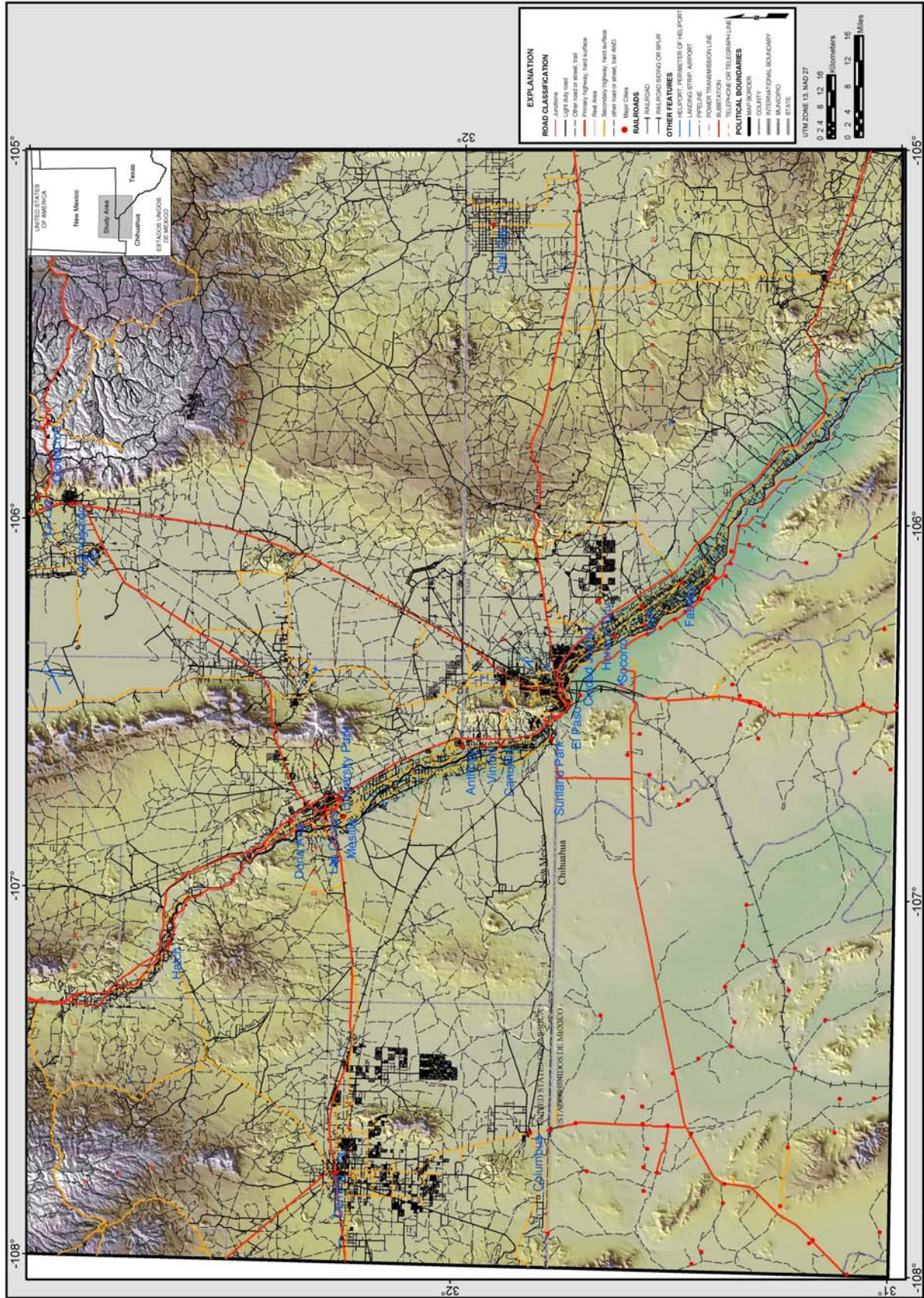
Map 7 illustrates the detail of the transportation theme. The contrast in the amount of detail on the Mexican the International Border is due to the availability of data at a large scale. The data on the US side was available at a scale of 1:100,000 where as the best available data on the Mexico side was at 1:250,000 scale. Progress is being made by the Centro de Información Geográfica, Universidad Autónoma de Ciudad Juárez to complete the transportation network for the urban areas.





Map 5. Map showing aquifers in the region.

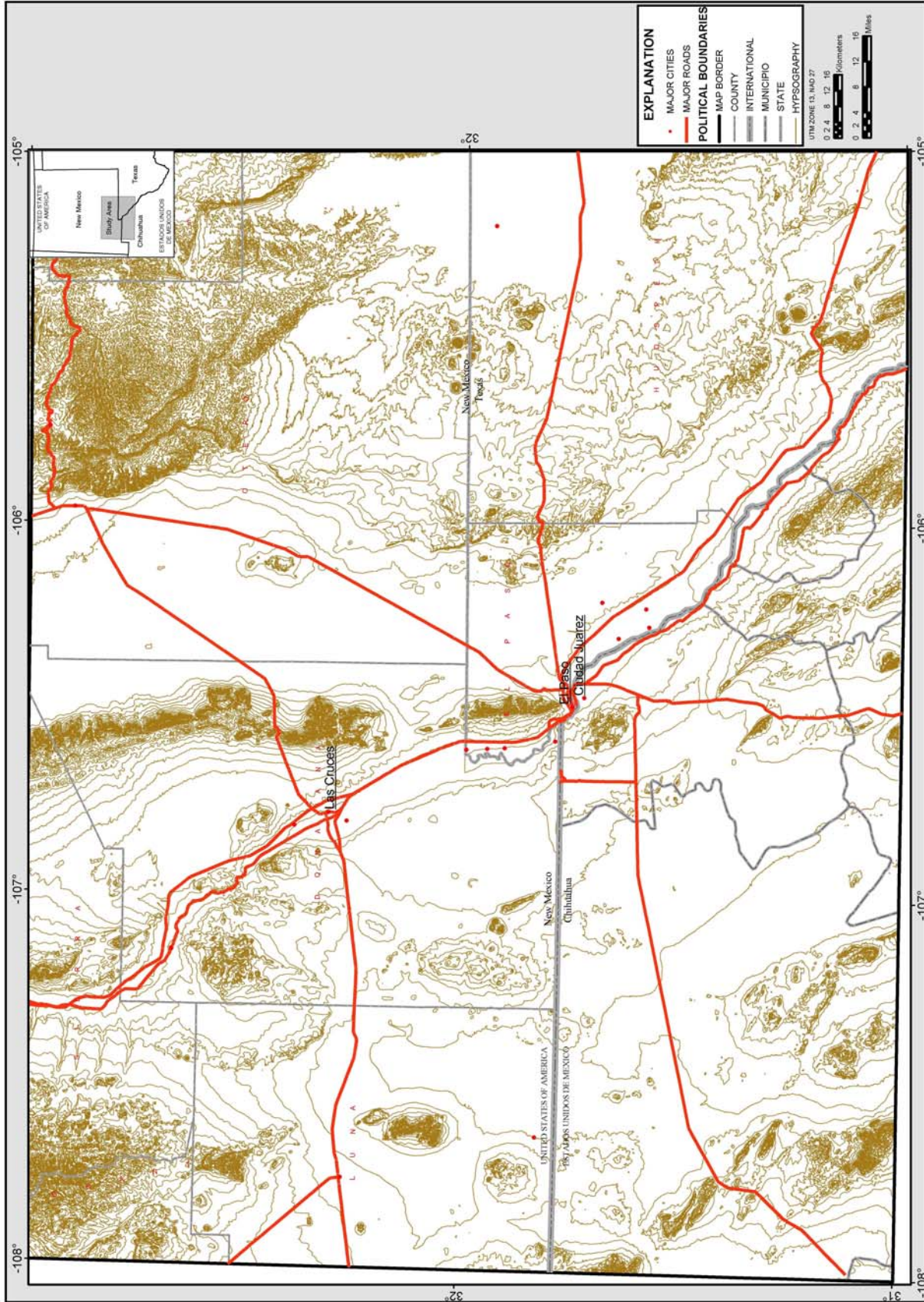




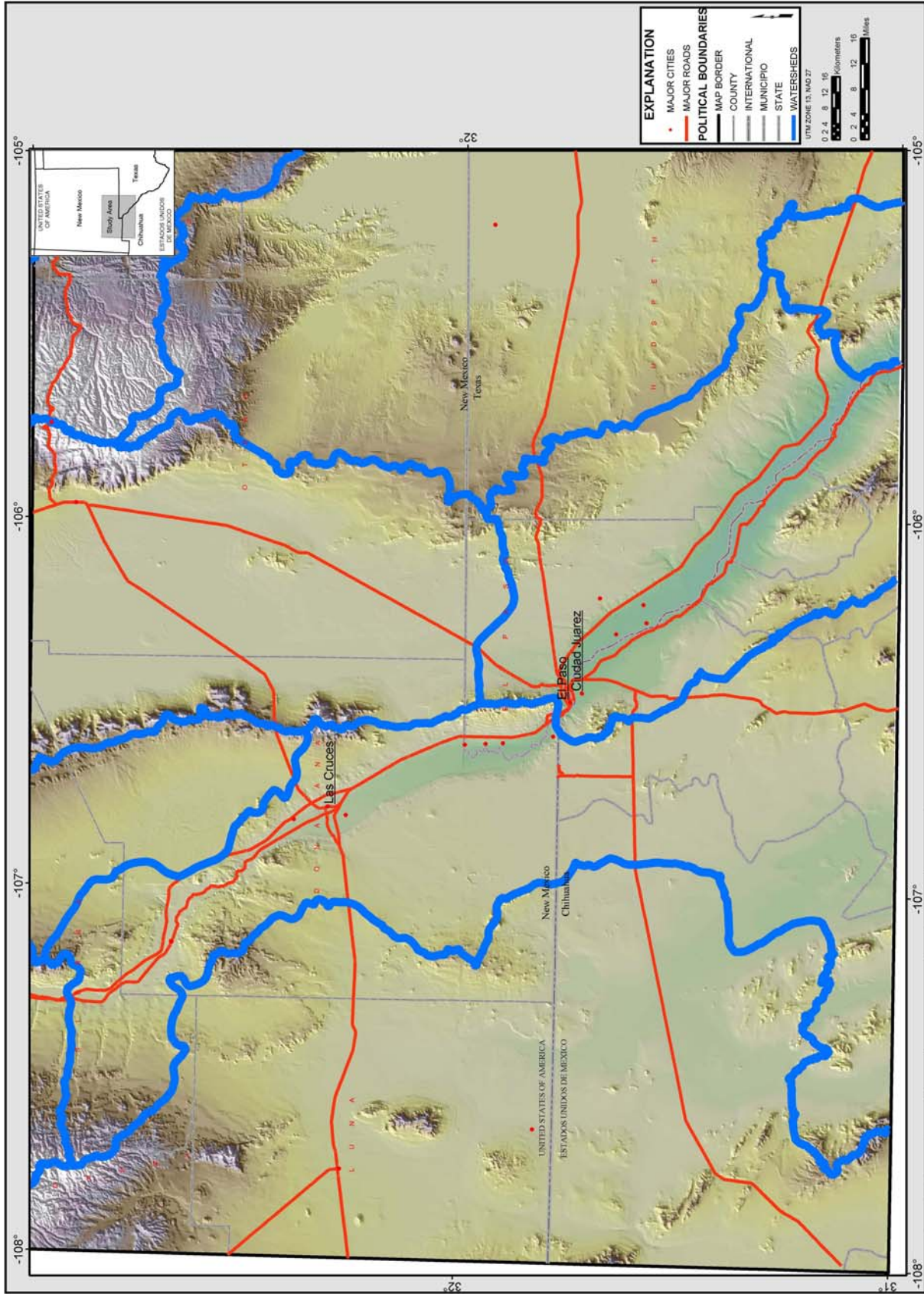
Map 7. Map showing transportations features in the region.

Map 8 illustrates elevation contours for the region. The contours are based on the digital elevation models shown as shaded-relief on the previous maps. The contour interval for these contours is 50 meters. This dataset requires updating as new data is made available through U.S.G.S. and INEGI (National Institute of Statistics, Geography and Information) mapping programs.

Map 9 illustrates the watershed boundaries for the region. The boundaries on the U.S. side are from the U.S.G.S. hydrologic unit code database. The boundaries on the Mexico side are derived from the 1:250,000 INEGI maps. This dataset requires further investigation as some sections along the International Border were shifted to align the data.



Map 8. Map showing the topography in the region.



Map 9. Map showing the watersheds in the region.

RECOMMENDATIONS

As has been noted in specific elements above, additional data items were identified that should be developed, but were beyond the scope of this effort. Also, shortcomings of specific data elements were identified and refinements should be undertaken to improve or correct.

The combined map themes developed become more valuable as users in both the region and elsewhere explore their use and suggest or offer their elements to the list. These efforts would be enhanced considerably with the development of an Internet map server system that would not only deliver the products but capture input from users. We therefore recommend that this concept be considered.

The technical team involved with this effort has also gained valuable experience that should be shared with other similar efforts along the border. Consideration should be given to sponsoring “go and show” visits for interested bi-national groups.

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