

# Geographic Information Systems, Remote Sensing, and Spatial Analysis Activities in Texas, 2008–09

## Introduction

Geographic information system (GIS) technology has become an important tool for scientific investigation, resource management, and environmental planning. A GIS is a computer-aided system capable of collecting, storing, analyzing, and displaying spatially referenced digital data. GIS technology is useful for analyzing a wide variety of spatial data. Remote sensing involves collecting remotely sensed data, such as satellite imagery, aerial photography, or radar images, and analyzing the data to gather information or investigate trends about the environment or the Earth's surface. Spatial analysis combines remotely sensed, thematic, statistical, quantitative, and geographical data through overlay, modeling, and other analytical techniques to investigate specific research questions. It is the combination of data formats and analysis techniques that has made GIS an essential tool in scientific investigations.

This fact sheet presents information about the technical capabilities and project activities of the U.S. Geological Survey (USGS) Texas Water Science Center (TWSC) GIS Workgroup during 2008 and 2009. After a summary of GIS Workgroup capabilities, brief descriptions of activities by project at the local and national levels

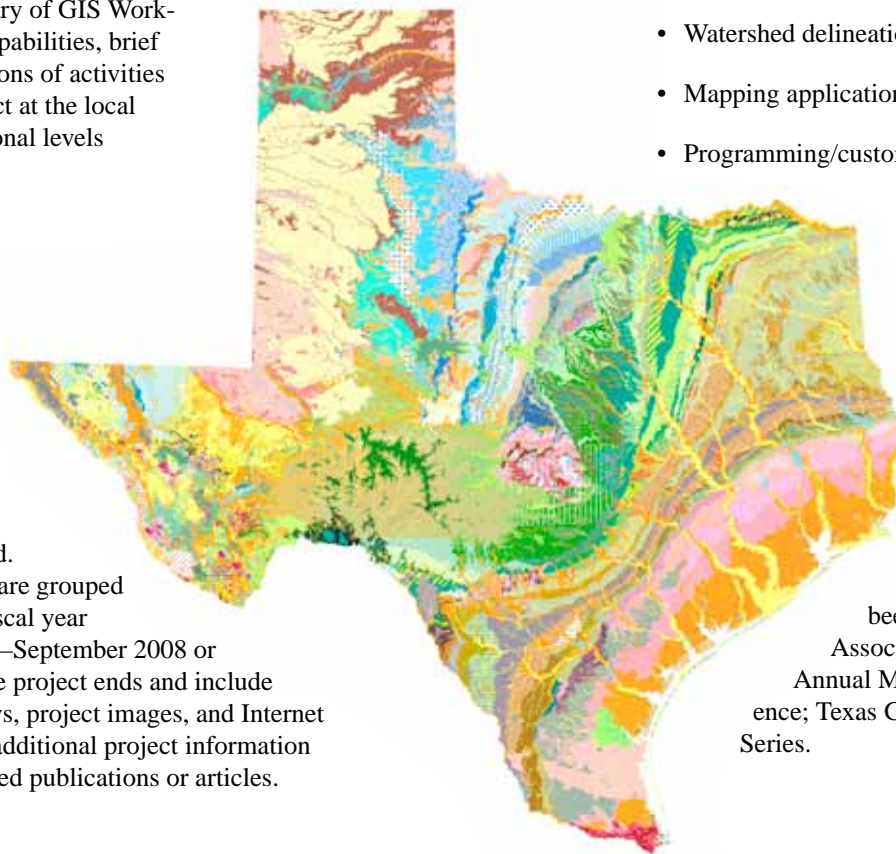
are presented. Projects are grouped by the fiscal year (October–September 2008 or 2009) the project ends and include overviews, project images, and Internet links to additional project information and related publications or articles.

## GIS Workgroup

The USGS Texas GIS Workgroup comprises geographers, hydrologists, and geologists in the Water Resources and Geography disciplines who specialize in GIS, remote sensing, and spatial analysis. We collaborate with hydrologists, hydrogeologists, water-quality specialists, limnologists, biologists, geologists, and geographers on a diverse range of projects. There is emphasis on technical training to keep skills current with advances in software and technology. Some of our technical capabilities include

- Spatial data production
- Spatial database administration and management
- Spatial data analysis and modeling
- Spatial data visualization
- Land cover/land use mapping
- Watershed delineation and characterization
- Mapping applications on the Web
- Programming/custom tools

The USGS Texas GIS Workgroup actively participates and collaborates with local, State, national, and international members of the GIS community. The Geospatial Liaison for Texas helps coordinate data collection, updates, and maintenance activities with local, State, and regional government entities. We regularly contribute to the knowledge base through presentations and publications. Several GIS projects have been presented at conferences such as the Association of American Geographers (AAG) Annual Meeting; ESRI International User Conference; Texas GIS Forum; and TWSC Technical Talk Series.



2008

### National Atlas and Global Map 1:1,000,000-Scale Hydrography Dataset—Version 1



In cooperation with the National Atlas of the United States®, the USGS produced a 1:1,000,000-scale networked drainage dataset from the existing 1:100,000-scale National Hydrography Dataset (NHD) for the United States, Puerto Rico, and U.S. Virgin Islands.

The USGS has developed specialized geoprocessing tools and algorithms using ESRI ArcObjects to partially automate generalization and simplification of the NHD network. The project was continued for 2009; see Version 2 under “2009.”

### Binational Water Quality Data Warehouse—Database Compilation



In cooperation with the International Boundary and Water Commission and agencies collaborating on the Border Environmental Health Initiative, the USGS has developed a Binational Water Quality Data Warehouse that provides a single source from which

interested parties can view and retrieve water-quality data relating to the U.S.-Mexico border region. These data are gathered by local, State, and Federal partner agencies. All data are stored in their original format, but they can be cross-referenced against other data with similar constituents from other agencies.

- Web site: <http://apps.ibwc.state.gov/BNQW/en/homeqwdata.asp>

### Watershed Boundary Dataset



The USGS collaborated in a multiagency effort to complete the national Watershed Boundary Dataset (WBD). In Texas, the USGS, in cooperation with the U.S. Department of Agriculture, Natural Resources

Conservation Service, used federally established standards (<ftp://ftp-fc.sc.egov.usda.gov/NCGC/products/watershed/hu-standards.pdf>) to delineate high-resolution watershed boundaries for several thousand 12-digit hydrologic units (or subwatersheds). Subwatersheds are the smallest WBD subdivision and range in size from 10,000 to 40,000 acres. The WBD has many potential uses by the public, private industry, and all levels of government in the management, analysis, and protection of natural resources.

- Web site: <http://www.ncgc.nrcs.usda.gov/products/datasets/watershed/>

### Edwards Adaptive Management



The USGS, in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency, compiled the Edwards Aquifer Data Clearinghouse to provide a single source from which interested parties can view and retrieve environmental and biological data

related to the Edwards aquifer. These data are gathered by local, State, and Federal partner agencies.

- Web site: <http://tx.usgs.gov/edwh/>

### Evaluation of Acoustic Doppler Velocity Meters (ADVMs) to Quantify Flow from Comal Springs and San Marcos Springs



The USGS, in cooperation with the Edwards Aquifer Authority, did a study during May 2006–September 2007 to evaluate ADVMs to quantify flow from Comal and San Marcos Springs. Comal Springs and San Marcos

Springs, the two largest springs in Texas, are major discharge points for the San Antonio segment of the Edwards aquifer and provide habitat for several federally listed endangered species that depend on adequate springflows for survival. Recent technological advances and availability of ADVMs now provide tools to collect data (stream velocity) related to springflow that could increase accuracy of real-time estimates of the springflows.

- 2008 USGS Scientific Investigations Report 2008–5083: <http://pubs.usgs.gov/sir/2008/5083/>

### Long Term Monitoring—Historical Flows Data Recovery



The USGS has a wealth of historical information in hardcopy records dating back to the early 1900s. A methodology to make historical records more accessible was developed using streamflow measurements, observations, and cross sections

for a gaging site on the Brazos River. A database was developed to store scanned and indexed historical records, facilitate searches, and link similar documents. The public can access and explore these data through the Long Term Monitoring Web site. An online search application facilitates data discovery and distribution.

- Web site: <http://txpub.usgs.gov/lrm>

### Interpretation of Faults Using Light Detection And Ranging (LIDAR)—Houston Area



The USGS, in cooperation with the Harris-Galveston Coastal Subsidence District, documented and refined the locations of principal faults mapped in the Houston area in previous studies.

Numerous subsurface faults have been documented beneath the Houston area at depths of 3,200 to 13,000 feet. Present-day fault scarps reflect only the most recent displacements of faults that were active long before the present land surface of the area was formed. The precision of previously mapped fault locations was enhanced by overlaying mapped faults on a digital elevation model (DEM) of Harris County derived using LIDAR. Previously mapped faults were adjusted to coincide with surface features that clearly indicate faults, which were made visible by the high-resolution topography depicted on the LIDAR-derived DEM. Results of a previous study, supported by this study, indicate that faults in the southeastern part of the Houston area primarily occur in well-defined groups of high fault density. Faults in northern and western parts of the metropolitan area tend to occur either individually or in pairs with little tendency to cluster in high-density groups.

- 2005 USGS Scientific Investigations Map 2874: <http://pubs.er.usgs.gov/usgspubs/sim/sim2874>

## National Atlas and Global Map 1: 1,000,000-Scale Hydrography Dataset—Version 2



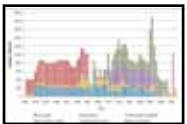
In cooperation with the National Atlas of the United States®, the USGS is producing a 1:1,000,000-scale networked drainage dataset from the existing 1:100,000-scale National Hydrography Dataset for the United States, Puerto Rico, and U.S. Virgin Islands. Streams and waterbodies datasets are intended to fulfill cartographic and analysis objectives. Topologically correct, geometrically networked datasets produced for this version are submitted to National Atlas cartographers for thorough cartographic review. The final datasets will be available through the USGS National Atlas in shapefile and geodatabase formats (<http://www.nationalatlas.gov/>) and through the Global Mapping Project (<http://www.iscgm.org/>).

## Rio Grande Data Project and Web Mapping Application



In cooperation with the U.S. Army Corps of Engineers, this project involves design and implementation of a Web mapping application to provide public access to restoration and civil works project information, base-map data, and fire-related datasets in the Rio Grande watershed in New Mexico. The public will be able to search project information on the basis of spatial location and tabular data.

## Rio Grande Salinity Study



In cooperation with the U.S. Army Corps of Engineers and the Rio Grande Salinity Management Coalition, the USGS will document existing salinity data and information, identify critical data gaps, and conduct a review of existing salinity research in the Rio Grande Basin from San Acacia, N. Mex., to Fort Quitman, Tex., to develop a plan of study to address salinity issues in this reach of the Rio Grande. High concentrations of dissolved solids (the indicator of salinity) in the Rio Grande Basin continue to be a major concern for water-resource managers. The problems associated with high salinity are important as rapid urban growth increases water demand and drives changing urban, agricultural, and environmental conditions and water uses.

## U.S.-Mexico Border Geographic Information System



The United States-Mexico GIS is based on fundamental datasets that are either produced or approved, or both, by the national geography agencies of each country (the USGS and the Instituto Nacional de Estadística, Geografía e Informática of Mexico) and the International Boundary and Water Commission. The USGS is collaborating with these agencies to make compatible geospatial and thematic datasets at various scales to allow local and regional analysis. Datasets for watershed boundaries, networked

hydrography, waterbodies, and census population are in progress.

- 2008 USGS Fact Sheet 2008–3069: <http://pubs.usgs.gov/fs/2008/3069/>
- Data download page: <http://borderhealth.cr.usgs.gov/datalayers.html>
- Internet Map Service: <http://borderhealth.cr.usgs.gov/IMS.html>

## Houston-Galveston Region Annual Maps



In cooperation with the Harris-Galveston Subsidence District, City of Houston, Fort Bend Subsidence District, and Lone Star Groundwater Conservation District, the USGS uses water-level measurements in wells in the Houston-Galveston region to produce annual maps of water-level altitudes, water-level changes in the Chicot, Evangeline, and Jasper aquifers, and compaction (land-surface subsidence) over time in the Chicot and Evangeline aquifers.

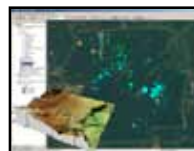
- 2008 USGS Scientific Investigations Map 3031: <http://pubs.usgs.gov/sim/3031/>

## National Water Information System (NWIS) National Coordination and Enabling Spatial Context



NWIS stores data collected by the USGS to investigate the occurrence, quantity, quality, distribution, and movement of surface water and groundwater. The public and outside agencies can access data through NWIS Web (<http://waterdata.usgs.gov/nwis>). To facilitate studies and data analysis, a process has been developed to extract a snapshot of data from NWIS. The snapshot process exports the data into a spatially enabled database schema, actively incorporates improvements, establishes relationship classes to link site information with related tabular data, and applies domains to automatically interpret internal NWIS codes. The result is a user-friendly, ESRI personal geodatabase containing site information, water-quality data, and groundwater data for the selected sites, which is then used in a variety of water-resource projects.

## Geodatabase and Three-Dimensional Conceptual Model for the Longhorn Army Ammunition Plant (LHAAP)—Management Phase



The USGS, in cooperation with the U.S. Environmental Protection Agency (USEPA), has developed an LHAAP geodatabase to provide a reliable analysis and decision-making tool. In the latter part of 2008, the geodatabase was used as part of the USEPA Superfund cleanup process for hydrologic monitoring, management, proposed cleanup plan, and protection of various resources on adjacent Caddo Lake on the Texas-Louisiana border. The comprehensive geodatabase also assisted resource managers to determine well placement and differentiate aquifer zones to analyze groundwater flow. In 2009, the geodatabase



will continue in management phase as additional hydrologic data are collected during spring and fall.

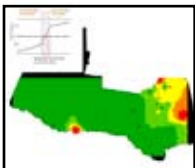
### **SPATIally Referenced Regressions On Watershed (SPARROW) Attributes Model Development**



The USGS is developing a SPARROW model that uses watershed modeling to relate water-quality measurements made at a network of monitoring stations to attributes of the watersheds containing the stations. The core of the model consists of a nonlinear regression equation describing the non-conservative transport of contaminants from point and nonpoint sources on land to major streams through the stream network. The model predicts contaminant flux (mass [or weight] per unit time crossing a unit cross-sectional area), concentration, and yield in streams. The model has been used to evaluate alternative hypotheses about the major contaminant sources and watershed properties that control transport over large spatial scales. Predictions and analytical results are illustrated through detailed maps that provide information about nutrient loadings at multiple scales for specific basins or geographic areas, even in unmonitored areas.

- Web site: <http://water.usgs.gov/nawqa/sparrow/>

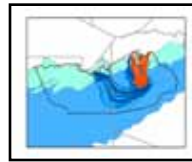
### **Modeling Relations among Environmental Changes, Contaminant Trends, and Human and Wildlife Health along the Rio Grande from Laredo, Texas, to the Gulf of Mexico**



The USGS, in collaboration with the Pan American Health Organization, is researching a tool that will help public health specialists identify human populations at risk for health-related problems on the basis of environmental quality. The project objective is to determine if evidential relations between general environmental or water-quality variables and fish or human health can be detected. A weights-of-evidence and weighted logistic regression approach applying geospatial statistical tools (ArcSDM) will be used to analyze the spatial relation of various indicators of environmental quality (for example, contaminants, water quality, soil geochemistry, land use) relative to measures of fish and human health.

- Web site: <http://borderhealth.cr.usgs.gov/>

### **Binational Water Quality Data Warehouse—Database Updating**



In cooperation with the International Boundary and Water Commission and agencies collaborating on the U.S.-Mexico Border Environmental Health Initiative (<http://borderhealth.cr.usgs.gov/>), the USGS is updating the Binational Water Quality Data Warehouse with additional information and metadata and updating the online delivery method where data can be accessed either by viewing thematic maps or by selecting criteria from a form. Summaries of available data for each site are provided on individual site pages, which can be accessed from a form or by providing an agency's site identification number.

- Web site: <http://apps.ibwc.state.gov/BNQW/en/homegwdata.asp>

### **National Water Quality Assessment Study of Transport of Anthropogenic and Natural Contaminants to Public Supply Wells**



The study of public supply well vulnerability is one of five national priority topics being addressed by the USGS National Water Quality Assessment Program. A supply-well-scale groundwater flow model, evaluations of model uncertainties, comparison of deterministic and probabilistic modeling approaches to chemical and hydrologic data, and sampling at different spatial and temporal scales are being implemented to better understand transport processes. The study aims to identify dominant contaminants and sources; assess effects of natural and anthropogenic processes on contaminant occurrence; identify factors that are most important in public supply well vulnerability assessments in different settings and at different spatial scales; develop simple methods and models for screening public supply wells for vulnerability to contamination in unstudied areas; and increase understanding of the potential effects of water-resource development and management decisions on water quality in public supply wells.

- Web site: <http://oh.water.usgs.gov/tanc/NAWQATANC.htm>

#### **For additional information, contact**

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