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16. Abstract

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DIGITAL SPATIAL DATA OF TEXAS: AN INTERNET AND LITERATURE REVIEW

by
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Research Report Number 1738-2

Research Project 0-1738
System of GIS-Based Hydrologic and Hydraulic
Applications for Highway Engineering

Conducted for the

TEXAS DEPARTMENT OF TRANSPORTATION
in cooperation with the
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research
THE UNIVERSITY OF TEXAS AT AUSTIN

August 1997

SUMMARY

A hydrologic spatial database of the drainage area of the Gulf of Mexico that spans the area from the Sabine River to the Rio Grande has been prepared. A brief description of the data, as well as how to obtain them, is also given. The database includes the following files: (1) digital elevation models, (2) reach files, (3) hydrologic units, (4) precipitation, (5) soils, (6) land use, (7) political, (8) reservoirs, (9) aquifers, (10) roads, and (11) raster maps (scanned).

DISCLAIMERS

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas Department of Transportation (TxDOT). This report does not constitute a standard, specification, or regulation.

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NOT INTENDED FOR CONSTRUCTION,
BIDDING, OR PERMIT PURPOSES

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DIGITAL SPATIAL DATA OF TEXAS: AN INTERNET AND LITERATURE REVIEW

Given the increasing use of geographic information system (GIS) technology, several federal, state, and local agencies, as well as a number of private organizations, have developed and are developing geographic information in digital format. For this project, we are particularly interested in hydrologic spatial data — related to the design of highway drainage facilities — of the drainage area of the Gulf of Mexico that spans the area from the Sabine River to the Rio Grande.

This report presents digital spatial data of Texas. A brief description of these data, as well as how to obtain them, is also given. For reference purposes, the electronic version of this document (Microsoft Word 97) includes hyperlinks to the Internet sites related to the data. These sites, however, are continuously relocated, making it almost impossible to keep all the links updated.

The map projection used in this database is defined by:

PROJECTION ALBERS	
UNITS METERS	
PARAMETERS	
1ST STANDARD PARALLEL:	27 25 0.00
2ND STANDARD PARALLEL:	34 55 0.00
CENTRAL MERIDIAN:	-100 0 0.00
LATITUDE OF PROJECTION'S ORIGIN:	31 10 0.00
FALSE EASTING (METERS):	1000000
FALSE NORTHING:	1000000

1. DIGITAL ELEVATION MODELS

Digital elevation models (DEM) are sampled arrays of elevations for ground positions that are normally at regularly spaced intervals. Depending on their spatial resolution (cell size), Texas DEMs can be grouped according to the following criteria:

30 Arc-Second DEM

The Digital Chart of the World (DCW) DEM provides 30-by-30 arc-second — approximately 1-km cell size — digital elevation data, as explained in Global 30 Arc-Second Elevation Data Set.[1] These data have been produced from the Defense Mapping Agency's (DMA) 1:1,000,000-scale DCW contour and hydrology data. The DCW-DEM project of the USGS EROS Data Center includes the generation of 30 arc-second data for the entire world to be distributed on CD-ROM as major geographic regions are completed. As of January

[1] *As explained above, underlined references indicate interactive text in the digital copy of this report.*

1997, Africa, Antarctica, Asia, Australia, Europe, Greenland, North America, and South America are complete and available for distribution.

The 30" DEMs can be downloaded from the USGS EROS Data Center Internet site at Global 30 Arc-Second Elevation Data Set. Instructions for downloading, unzipping, and setting these DEM grids are available at How to Download a 30" DEM.

In this project, the 30 arc-second DEM was used for those areas where more detailed elevation data are not available, i.e., the part of the Rio Grande drainage area located in Mexico.

500-m DEM

The 500-m DEM is part of a compilation of geospatial data sets, formatted for use in GIS, prepared by the Global Energy and Water Cycle Experiment (GEWEX) for its Continental-Scale International Project (GCIP) Reference Data Set (GREDS), as explained in USGS - Metadata for GCIP Reference Data Set (GREDS). The data have been consistently integrated and written to a CD-ROM (USGS Open-File Report 94-388). Instructions on how to obtain the CD-ROM can be found online at USGS - Metadata for GCIP Reference Data Set (GREDS) - Distribution Information. The data sets, source scales, and projection were chosen to support the global change research community, specifically the GCIP, with input from the GCIP Data Committee and the GCIP Hydrometeorology and Atmospheric Subpanels. The 500-m DEM covers the conterminous United States and part of southern Canada, while most of the other data sets cover only the United States.

3 Arc-Second DEM

The 1-Degree DEM (3-by-3-arc-second data spacing) provides coverage in 1° by 1° blocks for all of the conterminous United States, Hawaii, and limited portions of Alaska, as explained in 1-Degree USGS Digital Elevation Models. The basic elevation model was produced by and for the Defense Mapping Agency (DMA), but is distributed by the USGS EROS Data Center in the DEM data record format. In reformatting the product, the USGS has not changed the basic elevation information. Such 1-degree DEMs are also referred to as "3 arc-second" or "1:250,000 scale" DEM data. Instructions for obtaining these data can be found at 1-Degree USGS Digital Elevation Models - Procedures for Obtaining Data.

A 500-m (547-yd) DEM for the study area has been included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM. This grid is the product of merging the 500-m DEM of the area within the United States (Texas, east New Mexico, south Oklahoma, and west Louisiana), with a resampled version of the 30 arc-second DEM of northern Mexico. Most grids that can be derived from the DEM, such as flow direction (flow network), and flow accumulation (drainage area), flow length downstream and upstream, have also been included in the CD-ROM.

2. REACH FILES

The U.S. Environmental Protection Agency (EPA) Reach Files are a series of hydrographic databases of the surface waters of the continental United States and Hawaii, as explained in The U.S. EPA Reach File Version 3.0 Alpha Release (RF3-Alpha) Technical Reference. The structure and content of the Reach File databases were created expressly to establish hydrologic ordering, to perform hydrologic navigation for modeling applications, and to provide a unique identifier for each surface water feature, i.e., reach codes.

A key characteristic of the Reach Files are their attributes that define the connected stream network. These attributes provide connectivity regardless of the presence or absence of topologic continuity in the digital linework. Flow direction is inherent in the connectivity attributes. This attribute-level connectivity enables the Reach Files to provide hydrologic ordering of stream locations using reach codes (what is upstream and downstream of a given point in the stream network), as well as network navigation proceeding in either the upstream or downstream direction.

The Reach File was first conceived in the 1970s with a proof-of-concept file known as Reach File Version 1.0 Alpha (RF1A), which was completed in 1975. The first full implementation, referred to as Reach File Version 1.0 (RF1), was completed in 1982. The source for RF1 was the USGS 1:250,000-scale hydrography maps that had been photo-reduced to a scale of 1:500,000 by the National Oceanic and Atmospheric Administration (NOAA). RF1 consists of approximately 68,000 reach segments comprising 1.04 million km (650,000 miles) of stream.

While RF1 still supports broad-based national applications, the need to provide a complementary and more detailed hydrologic network motivated the development of Reach File Version 2.0 (RF2) in the late 1980s. RF2 was created by using the Feature File of the USGS Geographic Names Information System (GNIS) to add one new level of reach segments to RF1. RF2 contains 170,000 stream segments. Shortly thereafter, widespread interest in providing a more comprehensive, nationally consistent hydrologic database led to the development of the Reach File Version 3.0-Alpha (RF3-Alpha).

The Reach File Version 3.0 (RF3) development project was begun in the fall of 1988 when the 1:100,000-scale DLG data became available. RF3 is being developed by EPA's Office of Water to provide a nationally consistent database to promote comparability for national, regional, and state reporting requirements, such as those found in 305(b) and other sections of the Clean Water Act. RF3-Alpha is now complete for 45 of the 48 contiguous states and Hawaii. In its present form, RF3-Alpha includes nearly 3,200,000 reaches representing streams, wide rivers, reservoirs, lakes, a variety of miscellaneous hydrographic features, and the coastal shorelines of the Atlantic and Pacific Oceans, the Great Lakes, the Gulf of Mexico, and the Hawaiian Islands. RF3-Alpha data requests should be directed to: STORET User Assistance (1-800-424-9067).

An RF1 line coverage for the study area has been included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

3. HYDROLOGIC UNITS

Hydrologic unit maps of the United States (and of each state) show the hydrographic boundaries of river basins and numeric codes assigned to each of them, as explained in Hydrologic Unit Maps. The maps were prepared in a cooperative project, initiated in 1972, between the USGS and the U.S. Water Resources Council. Boundaries and numeric codes are depicted for 21 regions, 222 subregions, 352 accounting units, and 2,100 cataloging units. River basins that have a drainage area greater than 1,813 sq. km (700 sq. miles) are delineated. Also included on the maps are state and county codes that use the Federal Information Processing Standards (FIPS). State maps are published on a scale of 1:500,000, and the U.S. map (out of print) on a scale of 1:2,500,000. The report "Hydrologic Unit Maps" (USGS Water -Supply Paper 2294) describes the maps and contains the numeric codes for the river basins.

Digital data sets for hydrologic units are available at scales of 1:2,000,000 and 1:250,000 at 1 to 2,000,000 Hydrologic Unit map of the Conterminous United States and Hydrologic units maps of the Conterminous United States, respectively. Each is a single coverage for the conterminous United States. Attributes of the 1:2,000,000-scale version include basin names. The digital data sets are available online in Spatial Data Transfer Standard (SDTS) format and in Arc/Info Export format.

As explained in Metadata for HUC250, converting to digital form the hydrologic-unit maps at a scale of 1:250,000 is part of the Geographic Information Retrieval and Analysis System (GIRAS) developed in the mid-seventies. The digital data are based on the Hydrologic Unit Maps published by the USGS Office of Water Data Coordination, together with the list descriptions and names of region, subregion, accounting units, and cataloging unit. The hydrologic units are encoded with an eight-digit number that indicates the hydrologic region (first two digits), hydrologic subregion (second two digits), accounting unit (third two digits), and cataloging unit (fourth two digits).

The data produced by GIRAS were originally collected on a scale of 1:250K. Some areas, though, notably major cities in the west, were recompiled on a scale of 1:100K. In order to link the data and use it in a GIS, the data were processed in the Arc/Info GIS software package. Within the GIS, the data were edgematched and the neatline boundaries between maps were removed to create a single data set for the conterminous United States.

The 1:250,000 HUC coverage for the study area is included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

4. PRECIPITATION

Mean monthly precipitation grids for the conterminous United States have been developed by Daly, Neilson, and Phillips ("A Statistical-Topographic Model for Mapping Climatological Precipitation over Mountainous Terrain," *Journal of Applied Meteorology,* 33, pp. 140-158, 1994). These grids are originally in Geographic Projection and have a cell size of 4.5 km (2.5 in.). The precipitation units are in mm/month.

Twelve mean-monthly and one mean-annual 5000-m precipitation grids of the study area are included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM. Data from Willmott, Rowe, and Mintz ("Climatology of the Terrestrial Seasonal Water Cycle," *Journal of Climatology,* Vol. 5, pp. 589-606, 1985) have been appended to these grids to cover the northern part of Mexico that drains into the Rio Grande.

5. SOILS STATSGO

Soil maps for the State Soil Geographic Database (STATSGO) were made by generalizing the detailed soil survey or SSURGO geographic database, as explained in State Soil Geographic Database (STATSGO). Since the base used for digitizing was the USGS 1:250,000 topographic quadrangles maps, STATSGO is intended for broad planning and management covering state, regional, or multicounty areas. States have been joined as one complete seamless database to form statewide coverages. Composition of soil map units was coordinated across state boundaries, so that component identities and relative extents would match. The number of soil polygons per 2.29-m (7.5-ft) quadrangle tile is between 100 and 400, and the minimum area mapped is 624.8 hectares (1,544 acres) (6 Km^2). STATSGO data are available for most states.

Each STATSGO soil polygon is linked to a Soil Interpretations Record attribute database. This attribute database gives the proportionate extent of the component soils and their properties for each map unit. The STATSGO map unit's framework consists of one to twenty-one components. The Soil Interpretations Record database includes over twenty-five soil physical and chemical properties for approximately 18,000 soil series recognized in the United States.

To obtain STATSGO soil spatial and attribute data, contact the National Cartographic and Geographic Information Systems Center of the USDA Soil Conservation Service (SCS) at P.O. Box 6567, Fort Worth, TX 76115 / Telephone: (817) 334-5559 / FAX: (817) 334-5290.

A STATSGO polygon coverage of the study area has been included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM. The percentage of each of the four hydrologic soil groups (A, B, C, and D) has been appended as additional attributes.

6. LAND USE

The Land Use and Land Cover (LULC) data files describe the vegetation, water, natural surface, and cultural features of the land surface, as explained in USGS Land Use and Land Cover Data. The United States Geological Survey (USGS) provides these data sets and associated maps as part of its National Mapping Program; they are available for most of the conterminous United States and Hawaii. This mapping program is designed so that standard topographic maps on a scale of 1:250,000 can be used for compilation and organization of the land use and land cover data. In some cases, such as with Hawaii, 1:100,000-scale maps are also used.

Manual interpretation of aerial photographs acquired from NASA high-altitude missions and other sources were first used to compile the land use and land cover maps. Secondary sources from earlier land use maps and field surveys were also incorporated into the LULC maps as needed. At a later time, the LULC maps were digitized to create a national digital LULC database.

The minimum area representing the man-made features of the LULC polygons is 4 hectares (10 acres), with a minimum width of 200 m (656 ft). This minimum width precludes the existence of very narrow or long tracts of data classification. Nonurban and nonman-made features may be mapped with polygons with a minimal area of 16 hectares (40 acres) that have a minimum width of 400 m (1,312 ft).

The LULC data are available (at no cost) through an anonymous FTP account at USGS Land Use and Land Cover Data - Procedures for Obtaining Data.

The land use/land cover polygon coverage of Texas has been included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

7. POLITICAL

As presented in Metadata for COUNTY100, a coverage of the county boundaries of the conterminous United States (Alaska, Hawaii, and Puerto Rico are available separately) has been prepared by the USGS at a scale of 1:100,000.

The part of the COUNTY100 coverage that corresponds to Texas has been isolated, projected, and included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

8. RESERVOIRS

Coverage of the reservoirs of Texas was supplied by the Texas Water Development Board (TWDB). No information about the coverage was obtained, but it was observed that the map projection was Albers equal-area and, by comparison with the EPA River Reach Files 1, that the resolution of the data was on a scale of 1:250,000 or finer.

The reservoir coverage is included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

9. AQUIFERS

Digital spatial data of the aquifers of Texas were digitized from 1:250,000 geologic maps by the GIS Planning Division of the Texas Water Development Board (TWDB). The resulting aquifer coverages (one coverage per aquifer) can be downloaded from the TNRIS Internet site Major Aquifers (e00 format).

A single major-aquifers coverage, obtained by joining all the one-aquifer coverages, is included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

10. ROADS

Road digital data of the U.S. Department of Transportation can be obtained from the TNRIS Internet site at Transportation - USDOT Data (e00 format).

Highway coverage of Texas is included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.

11. RASTER MAPS (SCANNED)

Digital raster maps have been prepared by Horizons Technologies, Inc., by scanning the corresponding USGS topographic paper maps.

Digital maps on a scale of 1:24,000 have been prepared for the states of California, Florida, Texas, Delaware, and Maryland. In these maps, state counties are grouped in order to fit on CD-ROMs. A total of twenty-one CD-ROMs are needed to cover the entire state of Texas.

Digital maps on a scale of 1:100,000 have been prepared for the entire United States. Two CD-ROMs are required to cover the state of Texas: one for north Texas, Kansas, and Oklahoma, and another for south Texas. At this scale, maps show major streets, highways, freeways, parks, hospitals, airports, waterways of all kinds, topographic contour information, selected place names, as well as other cultural information. Contours are at intervals of 5, 10, 20, or 50 m, depending on terrain relief.

Digital maps on a scale of 1:250,000 have been prepared for the United States. A total of five CD-ROMs are required for the entire United States. The midwest CD-ROM includes the states of North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas, New Mexico, Colorado, and Wyoming. At this scale, maps show county boundaries as well as state and federal reservations, major built-up areas, highway and water features, and limited topographic contour information.

Information about these digital raster maps can be found at Sure Maps! Horizons Technologies, Inc..

The digital raster map of Texas on a scale of 1:2,000,000 is included in the *Hydrologic Modeling in Texas Using GIS* CD-ROM.