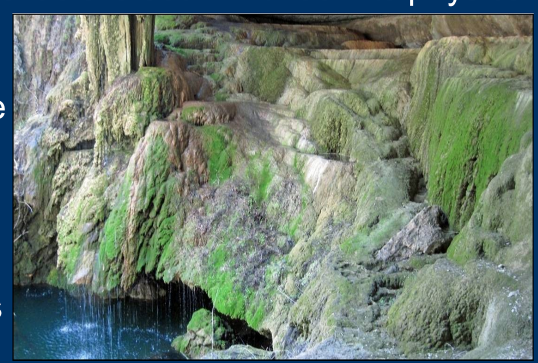
Texas Springs Project

Texas Hydrological Innovations

Background

Springs are naturally occurring features that, in Texas, have tremendous economic, cultural, ecological, aesthetic and recreational value. Springs can be formed in any kind of rock however most of the aquifers in Texas are sedimentary. A weak carbonic acid (a solution created from the mixture of precipitation and carbon dioxide gas) dissolves the rock creating caverns and aquifers (USGS, 2010). Aquifers are geologic formations that store and transmit ground water. Texas contains nine major aquifers and 21 minor aquifers (TWDB). The volume of water that flow from springs depend on many variables including; aquifer water pressure, the rock sizes in the cavern, spring basin, precipitation, and human use. Human use includes extraction for irrigation, recreation, agriculture, sanitation and consumption. Springs are recharged through precipitation. A Spring's health is a delicate balance between its physical characteristic, its use, and precipitation.



Spring flow can vary greatly. Some springs have relatively constant flow, while others fluctuated greatly according to precipitation and season. Flow from springs can range from thousands of gallons per minute (gpm) to almost nothing. Springs provide a variety of services for Texans and the animals communities that inhabit them. Texas' springs have remarkable importance and are a symbol of Texas' diversity.

Problem

Springs, in Texas, are documented by various agencies and organizations throughout Texas. The problem is that, a particular spring's coordinates and attribute data may vary according to its source. Many springs are duplicates of other springs. For the average person, the spring data is not easily accessible and is either in shapefile format or found through complicated queries from the source websites. The average person does not have access to ArcMap software and does not have GIS training therefore, the data is currently unavailable for many Texans.

Our goal was to combine the data from four primary databases (shown in Table 1) into one comprehensive database. The springs in the resultant comprehensive database will be in shapefile format, for those that have access to ArcGIS, and in a user friendly format, compatible with Google Earth, for those without ArcGIS access.

It is the goal of this project to create a resource for all those interested in learning more about Texas's springs. Through education and awareness we hope to generate a public interest to preserve one of Texas's most remarkable features.

Table 1. Shows the databases included in the comprehensive database. Spring totals for each database reflect differences between sources.

Database Source	Spring Total
Heitmuller and Reece (2003)	2,061
Texas Water Development Board (TWDB)	2,143
USGS Compilation of Historical Water-Quality Data in Texas	232
USGS National Water Information System (NWIS)	2,075

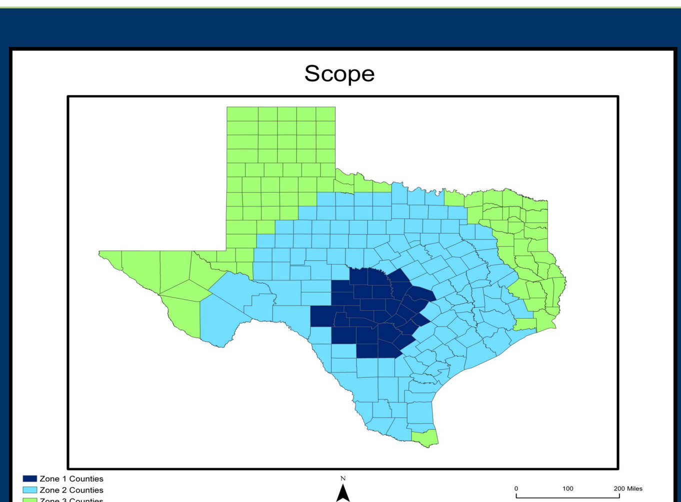


Figure 1. Shows the extent of this project. Zone color indicate analysis order.

Interactive Map

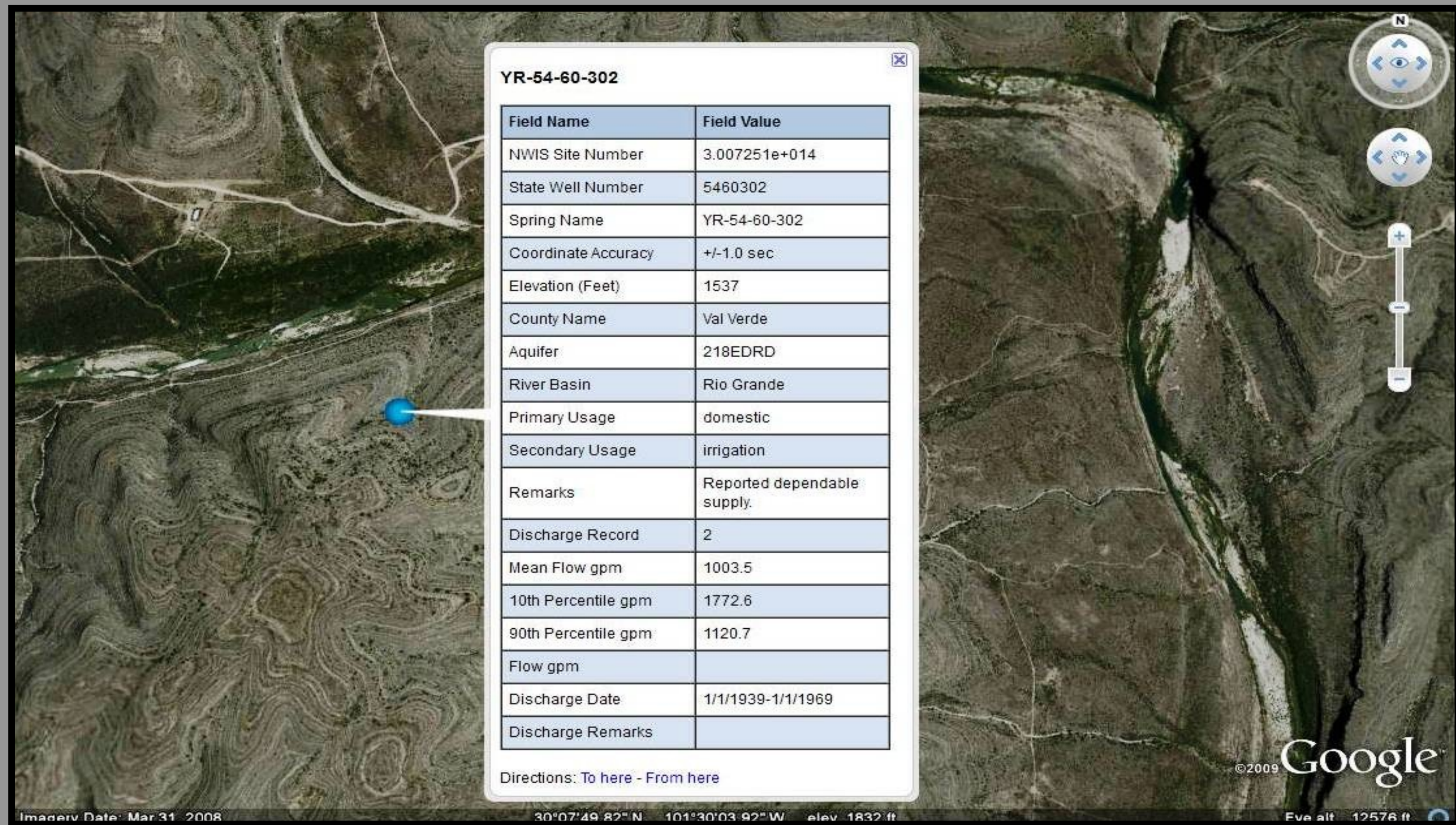


Figure 2. User friendly, interactive map. User is able view the location of all the springs in our database without having access to ArcMap. Widget feature, shown in table, displays attribute information for each spring.

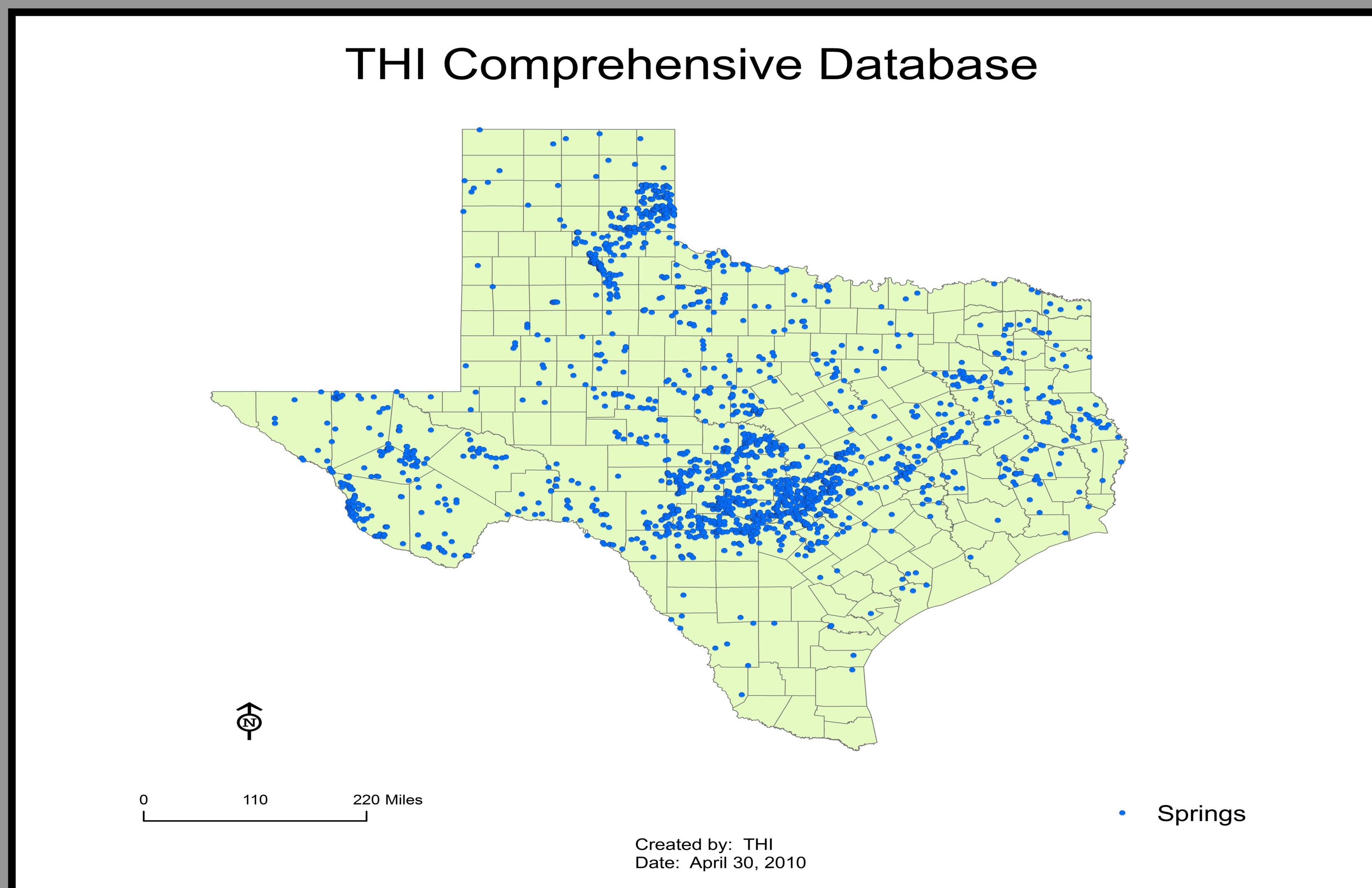


Figure 3. THI comprehensive database includes 2238 springs. Image shows our dataset, in shapefile format, represented in an ArcMap. GIS user will have access to all spring attribute data aggregated from four databases.

Results

THI created a comprehensive database for the springs in Texas, available in shapefile and .KMZ format. Our comprehensive database is provided with an attribute data table that includes both technical and nontechnical field names. The shapefile allows for efficient queries, of spring data, by any GIS user; whereas, the KMZ format was used to produced an interactive map compatible with Google Earth (shown in Figure 2). The interactive map, accessible on our website, allows for any user to have access to this data. The interactive map allows the user to easily navigate and locate the springs in Texas.

Procedures

THI integrated data from Heitmuller and Reece (2003), Texas Water Development Board (TWDB), USGS Compilation of Historical Water-Quality Data in Texas, and USGS National Water Information System (NWIS,) to create a comprehensive map-based database of the springs in Texas. THI created a standard for the categorization of the spring data. The standard was created by locating commonalities in attributes amongst the primary databases and determining which other attributes were pertinent to the study. Figure 4 outlines the overall project concept.

Creating Table 1 (Spring Attribute Table). Using the standard that THI created, a comparative analysis was completed and pertinent data was added when available. The springs were organized according to source and duplicate data was identified and removed. When the USGS spatial location for a spring was available, it was determined to be the most accurate. Elevation data was found in the Heitmuller and Reece (2003), TWDB, and USGS databases. When the Heitmuller and Reece (2003) elevation was available it was determined to be the most accurate. Owner information was only located in the TWDB database. For all other attributes, when available, Heitmuller and Reece was used first followed by NWIS, USGS Compilation of Historical Water-Quality Data in Texas and then TWDB. The attribute table was then simplified including common names for attributes to supplement the numerical codes used by GIS users to represent county name, river basin, coordinate accuracy, primary and secondary use.

Creating Table 2 (Discharge Table). Heitmuller and Reece (2003) discharge data was used to complete a statistical analysis. A standard for the statistical representation of the discharge data was created using Microsoft Excel. For each spring where there was available data, the number of records, the earliest and latest dates were recorded to give a temporal range. For springs with more than one record THI calculated the 90th percentile, 10th percentile, and mean flow.

Creating Final Table (Comprehensive Database). Both tables (Table 1 and Table 2) were imported into ArcMap where a join was performed to combine the tables. The joined table (comprehensive database) was then converted into a Keyhole Markup Language (KML) file. The KML file allows for the spatial display of the springs in Texas in an interactive format using Google Earth. Applicable field names in the interactive map were given an appropriate alias to better represent the attributes to a novice user.

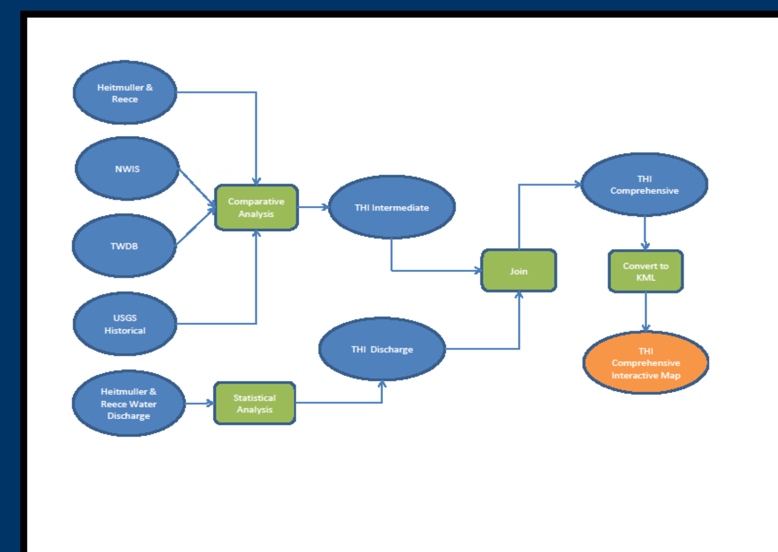


Figure 4. Illustrates the procedures described above.

Discussion

THI created a comprehensive database for the springs of Texas. Prior to the completion of this project, data for springs, in Texas, were scattered and difficult to manipulate. The THI Comprehensive Database, offers the user an easily navigable database that can be used as a reference for spring information or as a foundation for further research. Links are provided on the website to all of the databases THI referenced in addition to the THI Comprehensive Database

In order for Texas to conserve this finite resource, during a time when the population is expanding and a demand for water is increasing, aquifer use and recharge models can be implemented to generate high efficiency groundwater management. A highly prioritized objective of Texas Hydrological Innovations (THI) has been to generate more spring awareness.

With further research, aquifer analysis can be performed by those who desire to update our database. There are almost 800 springs that are missing aquifer source information. Discharge data collection of rivers and springs is a necessity in the continuation of this project. Many springs have no discharge or water quality records. In order to manage Texas' freshwater resource more efficiently, the statewide collection of discharge and water quality data is mandatory.

TEXAS HYDROLOGICAL INNOVATIONS
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