2010

Springs of Texas Database Proposal

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1 Introduction

1.1 Summary

Springs are an important and valuable natural resource for Texas. Springs in Texas have tremendous economic, cultural, ecological, aesthetic, and recreational value. The primary fresh water source for Texas is derived from ground water, which collects recharge from precipitation. The state of Texas and particularly the Hill Country are experiencing an abundance of population and development growth. The expanding growth requires a collaborated effort to ensure that there is enough fresh water to sustain for the current and future population.

Currently, Texas spring data can be found through the use and queries of various databases, which have been developed by various entities. The following sources are our primary databases that will be included in this analysis: 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), where spring data is collected and recorded. The databases currently exist in a heterogeneous format that results in inconsistencies among them.

Texas Hydrological Innovations is an organization composed of spatial analysts who specialize in water resources for Texas. It is a nonprofit organization that utilizes GIS tools for the improvement of freshwater management in Texas.

1.2 Purpose

Utilizing a Geographic Information System (GIS), Texas Hydrological Innovations will be able to categorize the springs, aquifers, limited water quality, and flow discharge data that will provide the user with a comprehensive database to perform further analysis. The goal of Texas Hydrological Innovations for this project is to integrate data from predetermined sources to create a comprehensive map-based database of the springs in Texas. Upon completion, the map based database of the springs will offer a quick and easily disseminated document that can be easily understood. The results of this analysis will provide a clear and concise location of the springs and the source aquifer in the prioritized zones.

1.3 Scope

The geographic extent of this study area includes the state of Texas and will be completed in a series of prioritized zones. Zone 1 includes 27 Texas counties and 962 springs issuing from Central Texas region (Figure 1). This region exhibits 45% of the total number of known springs in Texas and represents the Texas Hill Country. Zone 2 includes 131 Texas counties and 562 springs. The completion of Zone 1 and 2 represent 71% of the total number of known springs in Texas. Zone 3 includes 96 Texas counties and 619 springs. With the completion of all three zones, the study area will include a land area of 261,797 sq. miles, a water area of 6,784 sq. miles, 2,143 or 100% of the total number of known springs in Texas, and all 254 counties in Texas.

Project Matrix

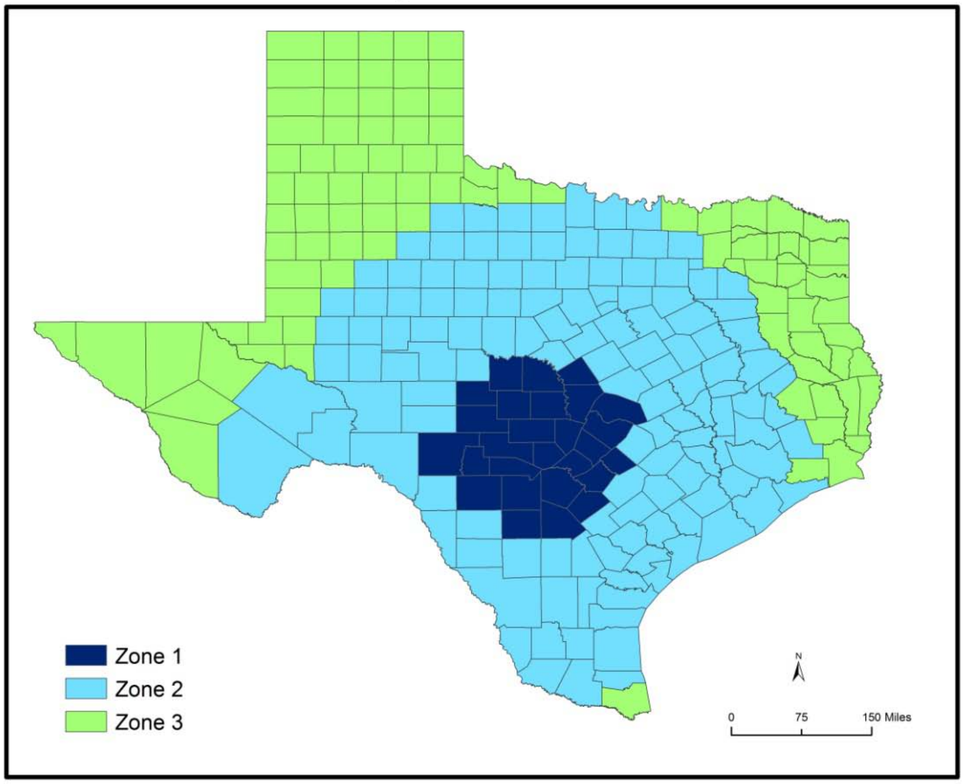

Figure 1. Zones indicate analysis organization and order.

1.4 Literature Review

"The importance of Texas groundwater has grown substantially in recent years due to population increase and drought" (Flores 2006). There is a need for extensive research on Texas' springs. Before the 1960s, little to no data was available on groundwater concerning the declining water table or Texas' springs. In fact, detailed studies have been made only in the last 50 years or so (Brune 1981). Gunnar Brune made it his life's work to research the past and current state of springs in Texas. Mr. Brune stated that "we desire the opportunity to work exclusively with Texas' natural springs. Data for manmade springs and wells will not be considered" (Brune 1981). His desire to work exclusively with natural springs in Texas provides our team with a dependable source that functions within the same scope as our project.

Natural springs have distinct characteristics that necessitate their existence. "There must be:

- An aquifer commonly composed of sand, gravel or limestone, that is capable of carrying water to the spring
- A sufficiently large recharge zone
- Rock beds level or sloping toward the spring
- Enough difference between the elevation of the recharge area and the individual spring's elevation to cause issuing of groundwater
- A water table high enough to form a substantial hydraulic gradient in the direction of the spring" (Brune 1981 pg4)

All of Texas' fresh water is replenished from precipitation collected on the Earth's surface and only 6% enters the water table. The remaining precipitation is lost to run off and evapotranspiration (Brune 1981). This suggests that ground water is far less reoccurring than perhaps commonly believed. If we can agree that spring water is the lifeblood of Texas, then we should agree that its preservation is obligatory. However, there is much evidence pointing to the decline of Texas' springs and their issuing aquifers.

Mr. Brune reported that "The story of Texas' springs is largely a story of the past. Many are gone" (Brune 1981 pgxvii). For example travertine, formed by precipitated calcium bicarbonate in spring water, has been found many meters above existing springs. This suggests that the water table and springs were once located at higher elevations and have since receded (Brune 1981). Another indication of spring decline is the loss of water loving trees. Many Cottonwoods to the west, Cypresses in the east, and Willows throughout the state of Texas are diminishing seemingly due to the decline of springs, caused primarily by man's actions. "Heavy well pumping of underground waters for irrigation, municipal, and industrial purposes has continued the decline and disappearance of Texas springs" (Brune 1975). Irrigation accounts for most of the groundwater usage. The USGS estimated that irrigation efforts generated around 6.4 billion gallons of groundwater withdrawal per day in 2000 (Flores 2006).

The majority of Mr. Brune's work provides collections of flow records, water quality analyses, contamination reports, historical documents and maps, archeological reports and biological studies related to springs which he collected before performing field work. Once in the field, Gunnar Brune performed chemical tests on spring water and studied geologic structure and lithology. He also took photographs of the springs in order to provide additional information on the environments found around Texas' springs (Brune 1981). Brune's research for 183 Texas counties was compiled and published in *Springs of Texas Volume One* in 1981. It was intended that data for the remaining 71 counties would be released by Mr. Brune in a follow-up edition to the original publication. Mr. Brune never finished the follow up edition pertaining to the remaining 71 counties. Helen Besse of the Ecological Recovery Foundation resumed the work of identifying the location of Texas' springs and their characteristics. She managed to compile much of the remaining unpublished data and notes collected by Gunnar Brune. She published the data for the TWDB in *Interim Report for Contract No. 2006-001-069*, which discussed the springs in the 71 counties that were excluded from *Springs of Texas Volume One.*

Throughout the state of Texas, other studies on springs have been conducted pertaining to specific regions. Extensive research has been done on the Edwards Aquifer while the Trans-Pecos region of Texas has received little attention. David Flores conducted research on the Trans-Pecos region of Texas in which he utilized the piper diagram in order to analyze water quality. The Piper diagram displays the major cations and anions contained in spring water and it depicts groundwater's previous interaction with geologic structures in the aquifer and recharge zones (Flores 2006). Such information will lead to a better understanding of aquifers and their spring's allowing for more advanced analysis and problem solving.

2 Proposal

2.1 Data and Methodology

This project aims to create a single comprehensive database using already existing digital data. Data will be aggregated from the following databases: 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). The data from these selected databases will be combined, analyzed, and utilized to create a shapefile format using ESRI ArcGIS. Proximity analysis and database queries will be used to remove duplicate spring records. Springs common to the selected databases will be classified as *confirmed* and springs where no confirmation can be made, or outliers, will be classified as *unconfirmed* and listed as pairs in a separate table. Attribute tables will be compared and a standard will be create using predetermined attributes. The resulting database will be in a shapefile format and the corresponding attribute table will have spring records aggregated by county. Time and resource permitting the shapefile could potentially be used to create a user friendly interactive map.

For the purposes of this analysis, each county was designated to a zone, which indicates priority: Zone 1-3 for high-low priority, respectively. We will begin our analysis concentrating first on the counties in Zone 1, then move on the each successive zone as time permits.

For some springs the source aquifer is unknown. For springs that have an unknown aquifer source and where water quality data is available, a water classification will be done using a Piper trilinear diagram. Water classifications of sampled springs can be made based on their dominant water type using seven major cations and anions. Water classifications can then be used to determine the source aquifer for springs where the aquifer is unknown.

2.2 Implications

This comprehensive database will potentially serve as a platform for additional data collection, documentation, and analysis for the springs in Texas. Ideally, this database will be used to add new or additional springs in order to build a more resourceful database.

2.3 Budget

Project Budget

Data Collection		
	Total Hours (2 hours / week * 5 weeks * 2 analysts managers + 2 hours / week * 5 weeks * 2 analysts)	40
	Hourly Rate	$25.00
	Subtotal	**$1,000.00**
Data Analysis		
	Total Hours (3 hours / week * 5 weeks * 2 analysts managers + 5 hours / weeks * 5 weeks * 2 analysts)	80
	Hourly Rate	$35.00
	Subtotal	**$2,800.00**
Project Preparation		
	Total Hours (2 hours / weeks * 2 weeks * 2 analysts managers + 3 hours / weeks * 2 weeks * 2 analysts)	20
	Hourly Rate	$25.00
	Subtotal	**$500.00**
System Management		
	Project Manager	
	Total Hours (3 hours / week * 10 weeks)	30
	Hourly Rate	$40.00
	Pay	$1,200.00
	Assistant Project Manager	
	Total Hours (3 hours / week * 10 weeks)	30
	Hourly Rate	$40.00
	Pay	$1,200.00
	Subtotal	**$2,200.00**
Web Management and Software		
	Web Master (Out Side Source)	
	Total Hours	30
	Hourly Rate	$50.00
	Pay	$1,500.00
	Software License for 10 weeks (12 months / $25,000 * 2.5 months)	$5,208.32
	Subtotal	**$6708.32**

Equipment Cost		
	Supplies ($250 / work station * 4 work stations)	$1,000.00
	Subtotal	**$1,000.00**
Travel Expenses		
	100 miles @ $0.50 cents / miles	$50.00
	Subtotal	**$50.00**
Total Cost		**$14,258.32**

2.4 Timetable

Texas Hydrological Innovations

Date	Progress
2/1/2010-2/15/2010	Collection of various spring databases and preparation of proposal
2/22/2010	Proposal submission
2/24/2010	Proposal presentation
2/16/2010-3/23/2010	Pre-processing data
3/31/2010	Progress report
3/24/2010-4/13/2010	Data analysis and database compilation
4/14/2010-4/22/2010	Production of deliverables: Interactive digital maps, a webpage, reports
5/23/2010-4/30/2010	Revisions and generate final report
5/5/2010	Submission of deliverables
5/5/2010-5/10/2010	Preparation for final presentation
5/10/2010	Final presentation

2.5 Final Deliverables

Final deliverables include:

- Detailed Final Report (2 copies)

- Poster for display in the Geography Department
- CD (2 copies) containing:
  - All data
  - Metadata
  - Report
  - Poster
  - PowerPoint Presentation
  - Instructions on how to use the CD
    - Readme file
      Note: Testing will be conducted to ensure no corruption will occur ad that all data is usable.

2.6 Conclusion

This project will research and establish a comprehensive database for spring locations and their contributing aquifers. It is the plan of Texas Hydrological Innovations to combine similar data collected from multiple data sources, resolve discrepancies in data, and build a comprehensive database for locations of springs in Texas and their associated source aquifers. Time permitting our analysis will include the full extent of Texas. Our goal is to create a central database that is easy to navigate and interpret while providing a foundation for continuous research for springs in Texas. We intend to provide a database that will support further research, documentation, and analysis for springs in Texas, which will improve freshwater management.

3 Participation

Team Member	Contribution
Ben Bates (Spatial analyst)	Budget, conclusion
Jason Picket (Spatial analyst)	Summary, purpose, scope, logo
Mark Pillion (Spatial analyst/Assistant Manager)	Literature review, references, timetable, logo
Yasmin Sierra (Spatial analyst/Project Manager)	Summary, methodology, data collection, maps

4 References

References

Brune, G. (1981). *Springs of texas*. Forth Worth: Branch Smith Inc.

Flores, D.A. (2006). *Using Major anions and cations to describe trans-pecos springs*. San Marcos: D.A. Flores.

Besse, H. (2006). *Interim report for contract no. 2006-001-069*. Retrieved from http://www.rivers.txstate.edu/projects/texas-springs/study-report.html.

The Texas State Historical Association, Initials. (2010). Facts. *Texas almanac*. Retrieved (2010, February 12) from http://www.texasalmanac.com/facts/.