BOBCAT
GEOSPATIAL SOLUTIONS

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Water Well Levels in the Texas Hill Country for the Hill Country Alliance

Prepared by:

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Introduction

Summary

Bobcat Geospatial Solutions (BGS) will create an online color-coded map for the Hill Country Alliance that will calculate recent water well levels for 18 counties that comprise the Texas Hill Country. The website we design will utilize historical data to calculate a range of percentiles that indicate the level of the well water. BGS will collect and collate data from several resources, such as United States Geological Surveys (USGS), the Texas Water Development Board (TWDB), and groundwater conservation districts (GCD), to create this website. The Hill Country Alliance (HCA) will host, maintain, and operate the interactive map on their web pages.

Purpose

HCA has requested that BGS create a color-coded map of water wells in the Texas Hill Country's 17 counties. Each well location on the map will display historical water level data from each well expressed in percentiles, a method that would allow for an easily understood analysis of the current drought severity based on historic conditions.

Although some well water data exists on a few websites, none provides a color-coded map to chart long-term changes in water well levels. Our research will assist HCA's study of the ongoing drought to determine its effects on the water supply in this region. HCA will use our data to eventually create a real-time study of water well levels in a more interactive map.

Scope

The study will include the 18 counties that encompass the Texas Hill Country (Burnet, Mason, Llano, Kimble, Gillespie, Blanco, Travis, Hays, Comal, Bexar, Kendall, Medina, Uvalde, Bandera, Real, Edwards, Kerr, Edwards). We will include only water wells with historical data of ten years or longer and more than 40 water level counts.

Literature Review

Since the 1960s, Geographic Information Systems (GIS) have evolved to store, manipulate, analyze, and present data. These capabilities make GIS an excellent tool to illustrate effects of human activities like pumping and natural events such as droughts and floods on groundwater levels. GIS can utilize groundwater measurements that have been collected over a period of time, and present them as maps and models that can help raise awareness about water conservation and protection.

For example, in a 2001 drought analysis, Taylor reports how the USGS in Pennsylvania calculated 70-year-old groundwater-level measurements in GIS to determine how long water rationing was necessary after the state began to experience some precipitation (2001). As the drought in Central Texas continues, the HCA needs ways to easily show water levels in wells and communicate future sustainability needs to stakeholders in the area.

As the population in Central Texas continues to expand with new development, the increasing number of residents will need to pump more water from wells, which will deplete water supplies especially without sufficient recharge. The HCA needs ways to educate stakeholders on trends in groundwater levels for water management purposes. GIS has been used worldwide to illustrate the need for water use regulation.

In India, GIS was used to assess the effects of irrigation projects on water levels in order to develop strategies for groundwater management (Chowdary, 2003). Using GIS, they were able to create models and display data layers that show the distribution of recharge rates. The illustrations that were created helped water professionals set the initial management framework. Our data layers will enhance the HCA's database of research to help create strategies to manage the diminishing groundwater for the Texas Hill Country. As the groundwater in the Hill Country becomes depleted, we will undoubtedly begin to experience problems with water quality. Water well studies have been used to help predict areas of possible groundwater contamination.

In Jordan, researchers produced maps to display where Azraq groundwater basin was likely to become contaminated (Al-Adamat, Foster, and Baban: 2003). They were able to incorporate other software and hydrography layers into GIS to create vulnerability layers both to illustrate the risk and to determine ways to avoid contamination. Not only can GIS display collected information about a certain aquifer, but it can also manipulate collected measurement data from one location to calculate water levels another.

At current pumping rates, studies show the Edwards-Trinity Aquifer level will continue to fall by about a foot a year (Wilder 2010). However, effects on individual wells and springs is still unknown because current "groundwater models work on mile-by-mile grids." More studies are needed to determine the specific effects continued and increased pumping will have on ground and surface water levels throughout the Hill Country. Better GIS models will help conservation agencies such as HCA better communicate the future of groundwater sustainability to various stakeholders.

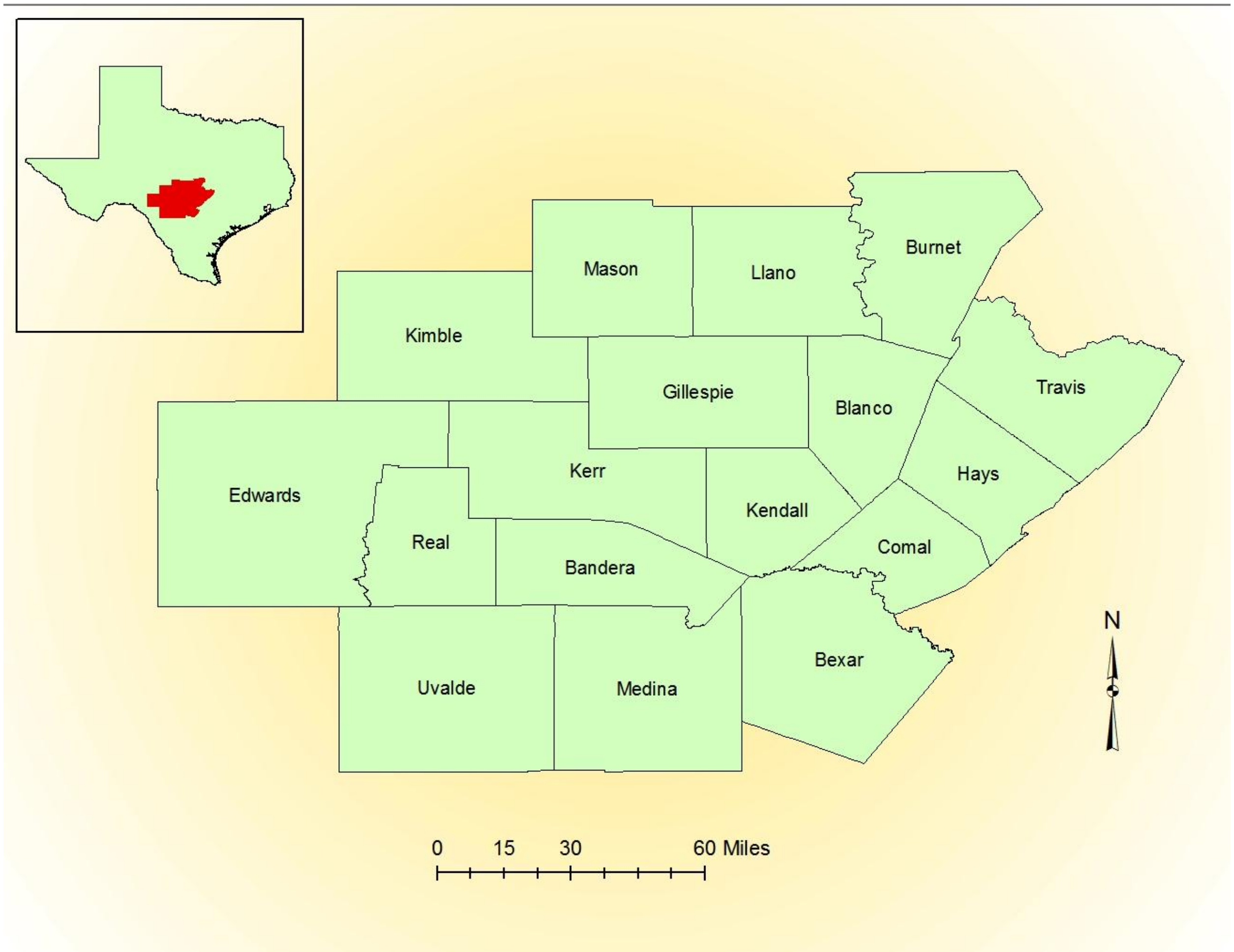

Figure 1. Seventeen County Hill Country Study Area

Proposal

Data

Bobcat Geospatial Solutions will be responsible for acquiring well data for the 17 counties listed in the Hill Country Association's area of study. BGS will acquire a DEM of Texas for finding elevations of each well. In order to display the research that is requested we will need to acquire data on the wells, county boundaries, and roads (Table 1). We will also need to implement a layer of our own placing the wells that meet the criteria into the mapping system for analysis. There will also be a layer for the percentiles of the wells. The data will be acquired from web sources including Federal and State agencies.

BGS will use ArcGIS10 to calculate the data into a spatial diagram.

Table 1. Data Layers and their sources. [1]

Layer	Source
County Boundaries	TNRIS
Roads	TNRIS
Urban Area	TNRIS
DEM	USGS
Wells	CAPCOG

[1]Abbreviations: Texas National Resource Information Systems (TNRIS); Capital Area Council of Governments (CAPCOG); United States Geological Survey (USGS).

Methodology

Our methodology for executing this project will begin with the collection of well data from both the United States Geological Survey and the Texas Water Development Board databases. Selection of the wells for the project will be based on criteria established by the Hill Country Alliance: All wells must have at least 10 years of data and at least 40 independent measurements over those 10 years. Any well not meeting those criteria will be eliminated. After all the well data has been collected, sorted and cross-referenced we will begin to obtain the historical records for groundwater levels of all the selected wells. Information collected at this stage will include the site name, well number, county identification, water level, and longitude and latitude data. For our map creation stage we will obtain county boundary, road, elevation, water system and terrain data from the Texas National Resource Information Systems. After uploading the relevant files all unnecessary data will be clipped by using an SQL equation and all remaining data will be organized into layers that contain only data for the Texas Hill Country. We will also use an SQL equation in the road, water system, terrain and elevation layers.

Our next task will be to add the well locations onto our map. Using Excel, a database will be created by first entering all the obtained well data into a spreadsheet and then importing it into the ArcGIS software. After the Excel spreadsheet has been imported into ArcGIS we will geocode all the well locations based on decimal latitude and longitude previously obtained. When all of the wells are properly geocoded we select an appropriate icon to represent our wells in the property window in this created layer.

While the maps are being geocoded, work will begin on calculating the percentiles for each well using the percentile software provided to us by the HCA staff and the historical records obtained previously. Using software provided by Raymond Slade of the HCA, we will be able to perform the mathematical calculations needed for the percentile work. After the percentiles have been calculated we will begin the integration of the results with the created maps. By using the editing tool in ArcGIS we will add the data that was created by the percentile software. By opening the attribute table we will add a new field to the table and add the percentile values for the corresponding well. Once the percentile data is added we will use the properties window to choose the proper display for the values. At this time we will also graduate the colors for the wells based on the established ranges for the percentile values. The percentile ranges will be 0-9, 10-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89 and 90-100. There will be an informational pop-up created for each well on the maps that will include the well identification number, county name, water level and location. The product of the percentile and map integration will be converted into a KMZ file and exported to Google Earth where the HCA will be able to build a real-time server for public use at a later date.

Implications

This project is for the use of Hill Country Alliance to be able to obtain knowledge on the groundwater levels and more specifically the well depths in the Hill Country region. The percentile program will allow for users to see the well depths in comparison to the historic levels of each well. This mapping system will provide useful information as far as groundwater levels for the Hill Country Alliance that perhaps in the future may be used by the public located in the Hill Country region of Texas.

Budget

Personnel	**Hourly Rate**	**Hours Per Week**	**Project Length**	**Total Hours**	**Total Cost**
Project Manager	$41.00	12	12 weeks	144	$5,904.00
Assistant Manager	$30.50	12	12 weeks	144	$4,392.00
Technician I	$21.50	12	12 weeks	144	$3,096.00
Web Master	$21.50	12	12 weeks	144	$3,096.00
Total Personnel Cost					$16,488.00
Equipment	**Description**	**Cost**			**Total**
Maintenance	4 computers	$175.00/month	12 weeks		$2,100.00
Supplies	4 computers	$200.00			$800.00
Depreciation*					$595.98
Total Equipment Cost					$3,495.00
Data					**Total**
Software	ArcView (4)	$3,500.00/1 year	12 weeks		$3,500.00
	Extensions (2)	$2,500.00			$5,000.00
Purchased					$1,200.00
Total Data Cost					$9,700.00
Total Project Expenses					$29,683.00

*Depreciation= $2,384.00 per computer X 4 computers / 48 months (life) X 3 months (use) = $595.98

Timetable

Most of the initial data collection will take two weeks but will be ongoing as the need for new data arises. After the processing and cleanup, we will simultaneously begin percentile work and the map creation. Once percentile work and map creation is complete, we will begin to integrate of the two. When the integration is complete, we will create the website, as the final step. Based on the schedule provided below, all deliverables should be completed and ready for delivery by December 5, 2011.

Start Date	Task	Due Date
Wednesday, Sept. 7	Start Proposal (Introduction and literature review)	Wednesday, Sept. 14
Wednesday, Sept. 7	Start obtaining well data (divide work load)	Monday, Sept. 19
Wednesday, Sept 14	Finish Preliminary Proposal (Data, methodology, implications and budget)	Monday, Sept. 19
Wednesday, Sept. 21	Data clean up (well elimination, cross referencing)	Wednesday, Oct. 5
Wednesday, Sept. 28	Client Presentation	Wednesday, Sept. 28
Wednesday, Oct. 5	Begin percentile work	Wednesday, Oct. 19
Wednesday, Oct. 5	Begin map work	Wednesday, Oct. 19
Wednesday, Oct. 19	Start combining percentile and map work	Monday, Oct. 31
Monday, Oct. 24	Start website creation	Monday, Nov. 28
Wednesday, Nov. 2	Start final proposal draft	Monday, Nov. 28
Monday, Dec. 12	Have all deliverables done	Monday, Dec. 12

Final Deliverables

By December 5, HCA will have a detailed final report, a professional poster for display in the Geography Department, a website, and two CDs containing the following:

All data

Metadata

Proposal, Progress, and Final Reports

Poster

PowerPoint Presentations

Instructions on how to use CD (*readme* file)

Conclusions

This proposal contains descriptions of the data, methodology, implications, budget, and a timetable for the completion of a color-coded map of both the location of water wells and a percentile of their levels in the Texas Hill Country's 17 counties. The water wells indicated in this study will have ten years of historical water level readings and at least 40 individual readings per HCA's request. Each well location will eventually link to real-time water level data in each well.

Participation

Charles Hill created the logo and map of the Texas Hill Country and helped with the literature review.

Sarita Hedgepeth wrote the Budget, Timeline, and Methodology sections and helped with the literature review.

Scott Lindsay helped with the literature review and created the Data portion of this proposal.

Teresa Santerre Hobby assembled the literature review, streamlined the proposal, and wrote the Final Deliverables, Conclusions, and Participation sections.

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