GIS in Water Resources Term Paper

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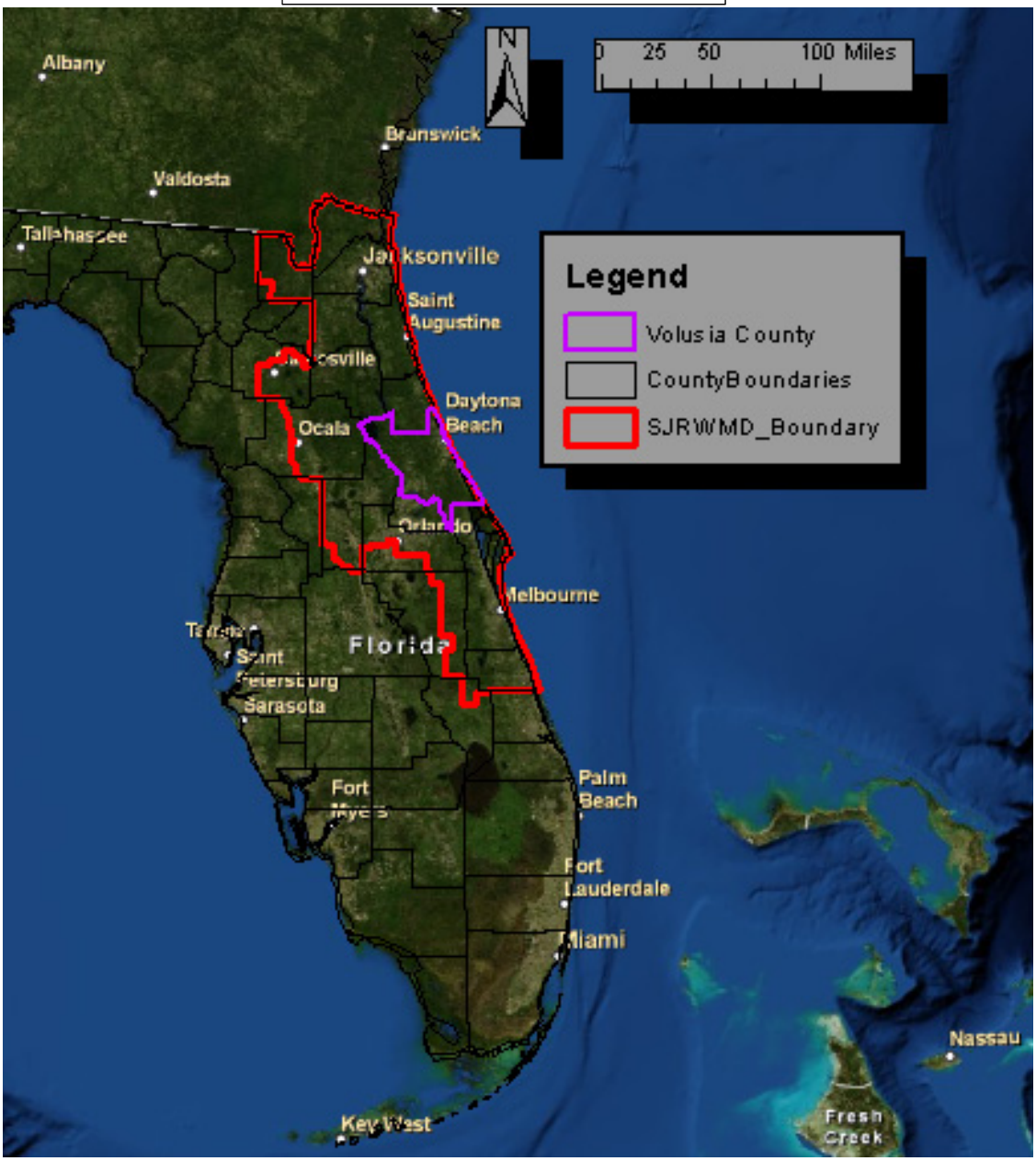
A Study of the Temporal Relationship between Groundwater Levels and Precipitation in Volusia County, FL

Introduction

Volusia County is located on the eastern coast of Florida (Figure 1). It is one of the counties that comprise the St. Johns River Water Management District (SJRWMD). Its population grew 11.6 percent from 2000 to 2010 (U.S. Census Bureau). Groundwater is an important resource in Volusia County. Since it is located on the coast, saltwater intrusion could be a problem with groundwater. Groundwater levels need to be monitored for this and many other reasons.

Figure 1. Location of Volusia County.



Objectives

The objective of this project was to analyze the available data for Volusia County and attempt to establish a temporal relationship between groundwater levels and precipitation. The time scale used would depend on the available data. ArcGIS was the main program used to do the analysis.

Method

Water level data and precipitation data were the two main inputs into the analysis. Water level data was retrieved from the USGS Groundwater Watch website (Figure 2).

Figure 2. USGS Groundwater Watch website.

There was data available for 33 wells in Volusia County. All of the wells were completed in the Floridan aquifer so the water levels represent the same aquifer. The water levels for all of the wells were measured from NGVD 29. The time scale used was 2000-2010. The majority of the wells had data available for all these years (Table 1).

Table 1. Well data

Year	# of wells missing data
2000	13
2001	5
2002	3
2003	4
2004-2010	0

To simplify things an average of water levels taken in May and September were used to get an average for the year which was the final water level used for the analysis. This information was input in an Excel spreadsheet and then imported into ArcGIS. A feature class for the USGS wells was created and the water level data for the wells was used to interpret groundwater levels for the entire county. The Kriging tool was used to interpret the groundwater levels.

Precipitation data was retrieved from the PRISM website. The data came in raster grids and was imported into ArcGIS. Map Algebra was then used to transform the data from millimeters into inches.

Results

The results of the work are shown in the following figures (Figures 3-8). Kriging was used to make interpretations of the groundwater levels for each year. Precipitation data was overlaid for the county. Only a select few years are shown here for groundwater levels and precipitation levels, but the analysis involved all years.

Figure 3. Groundwater levels 2000.

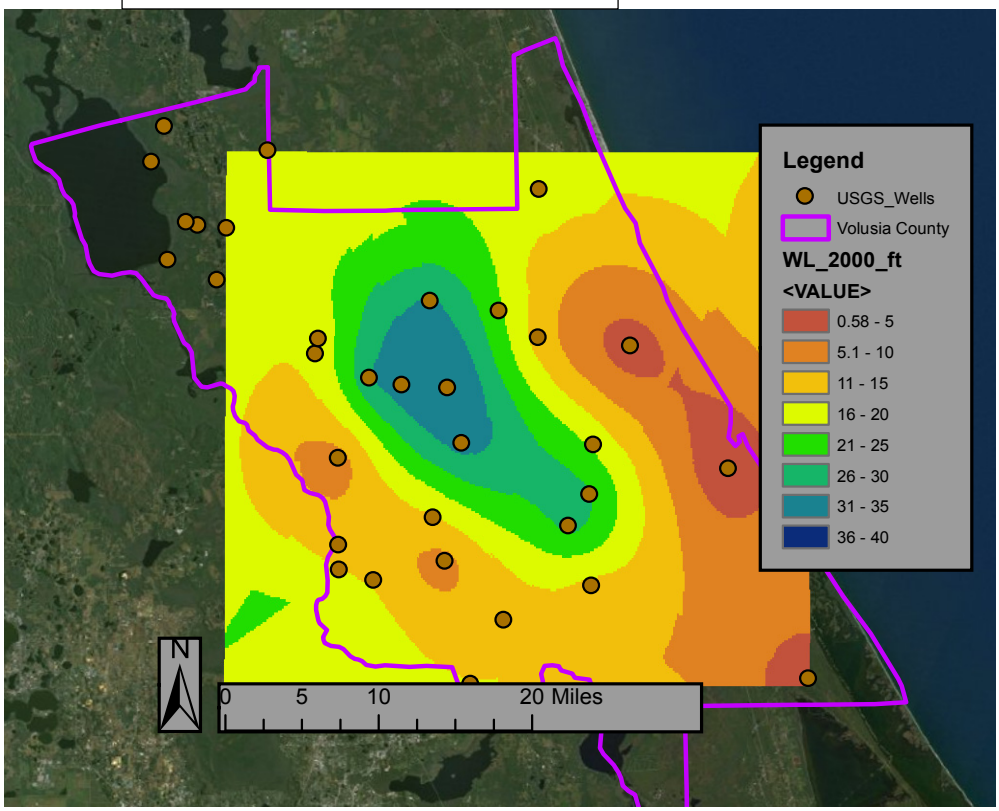


Figure 4. Groundwater Levels 2005.

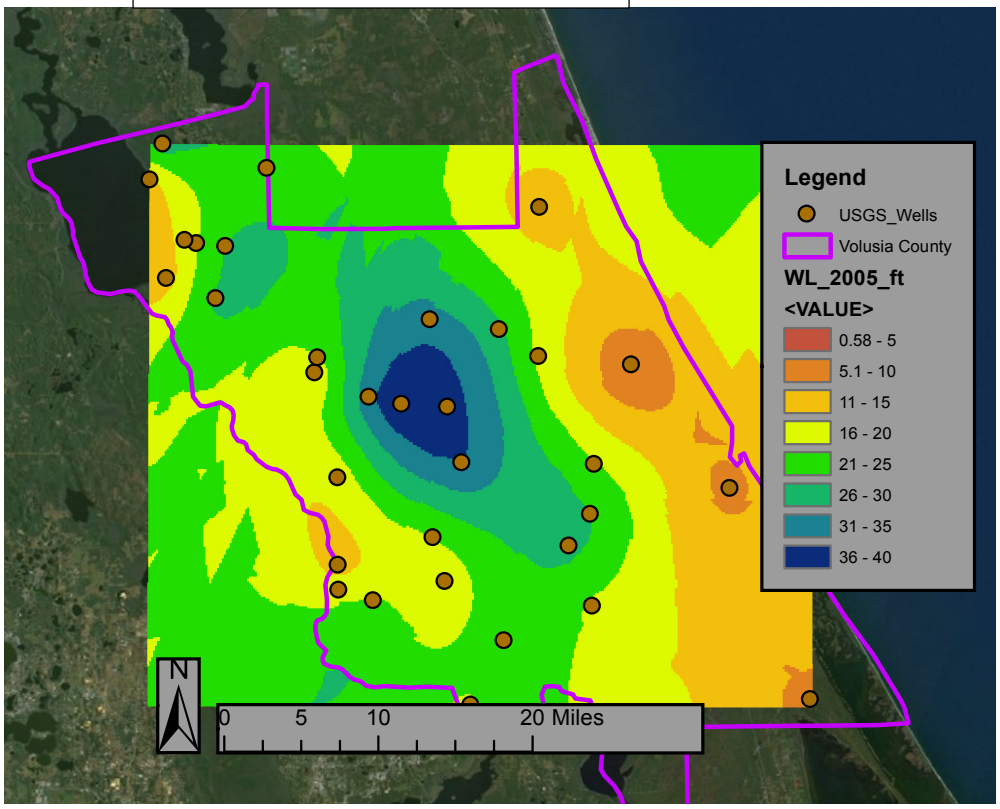


Figure 5. Groundwater levels 2007.

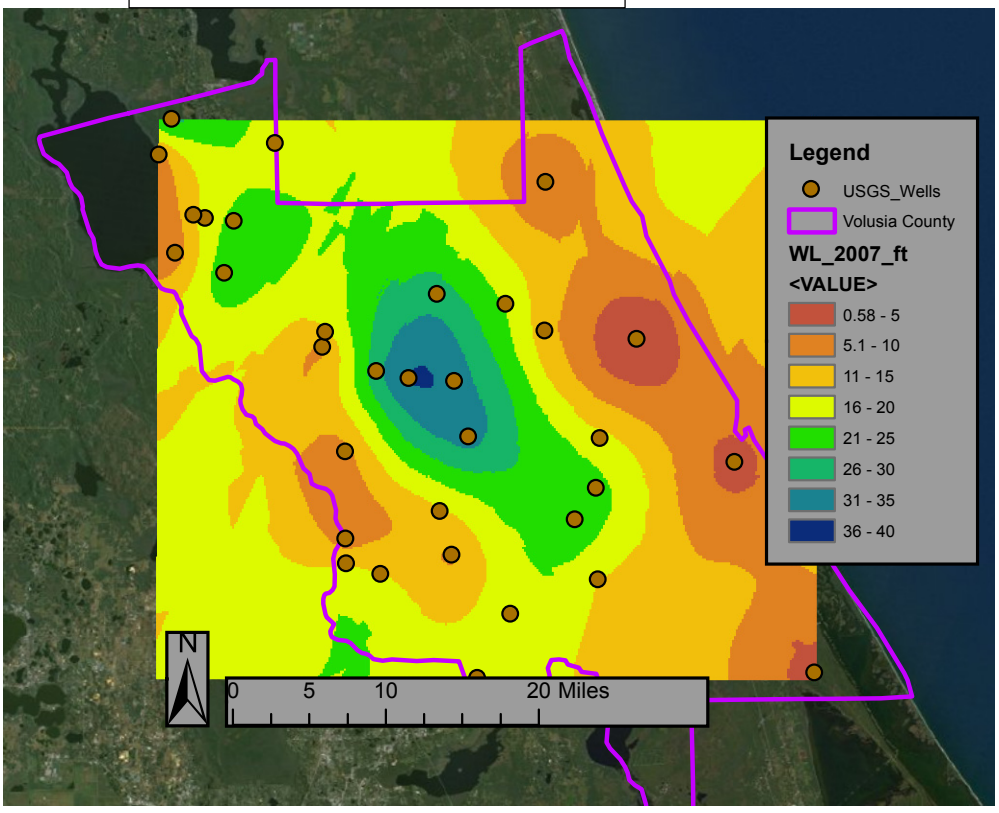


Figure 6. Precipitation levels 2000.

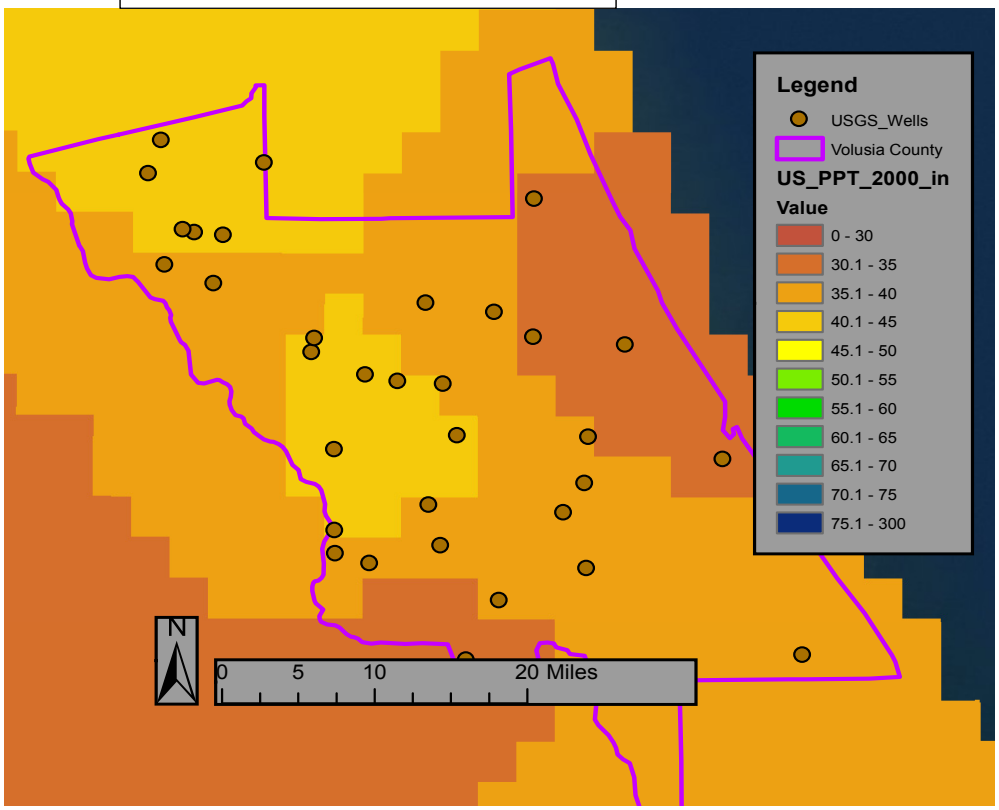


Figure 7. Precipitation levels 2001.

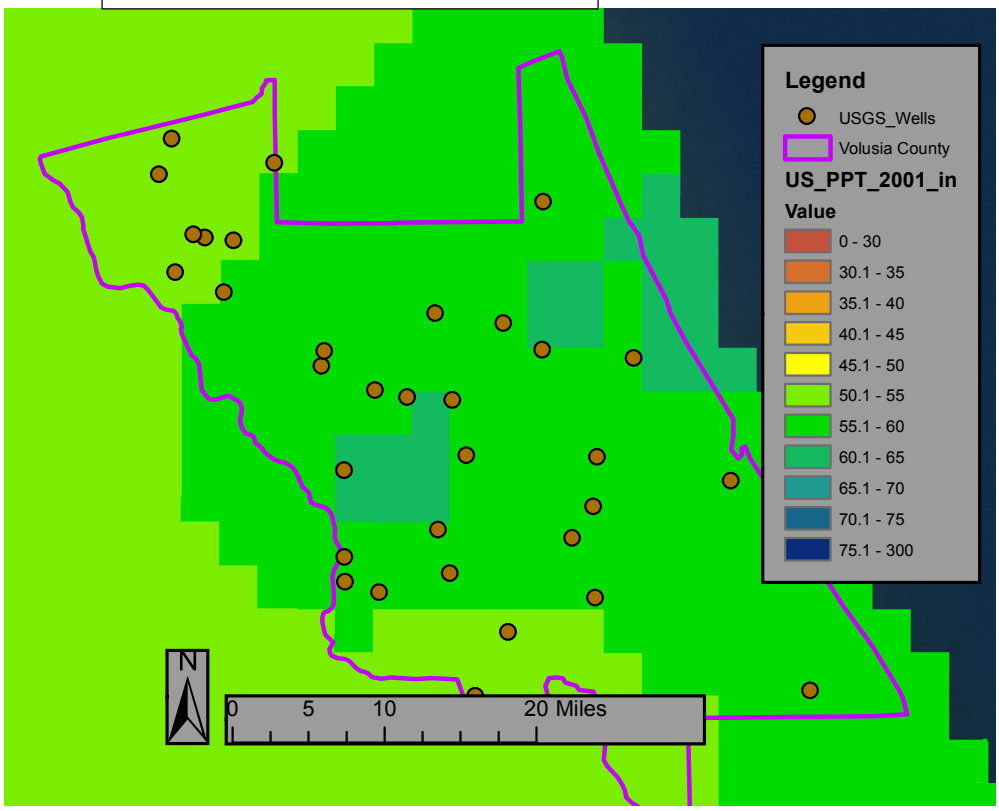
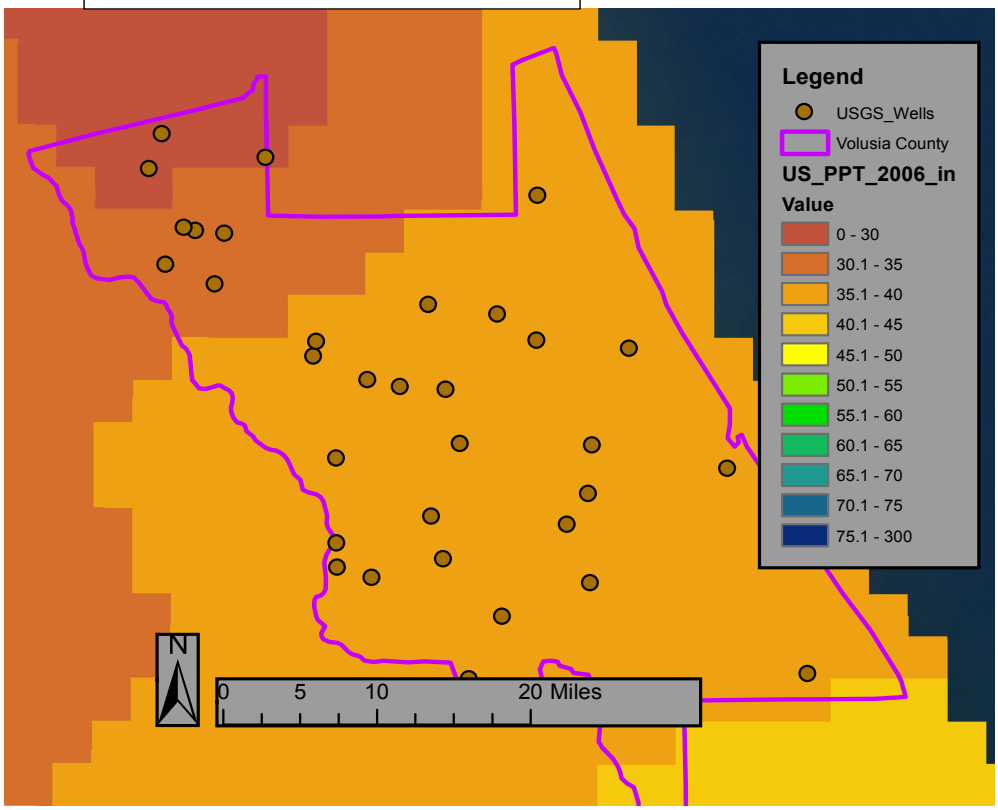


Figure 8. Precipitation levels 2006.



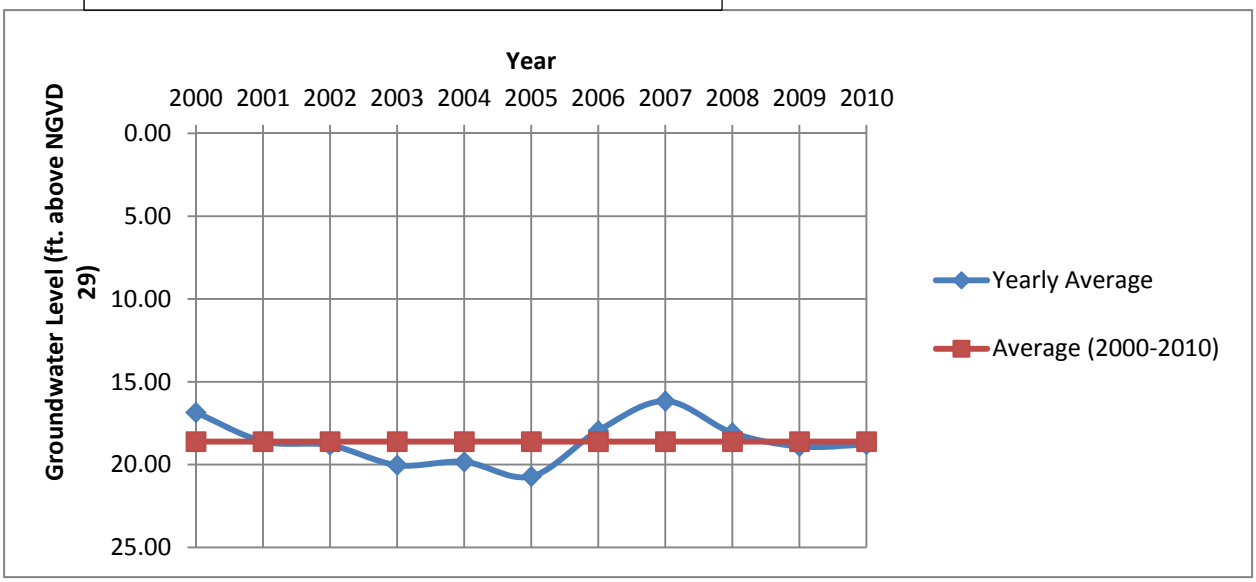
Discussion

The interpolated groundwater levels provide a fairly accurate representation of the groundwater levels and show enough detail for the analysis. The only problem is the few years that were missing data may have skewed some of those interpretations. One issue with the well data is that the well density for the county is probably not high enough for a detailed look at the groundwater levels, but for the scope of this project it is enough. The precipitation data is fairly suspect because there was no comparison with actual data from precipitation stations.

Conclusion

The groundwater levels and precipitation levels do not seem to show a temporal correlation. While the precipitation levels from 2001-2005 were steady, the groundwater level actual decreased. The year with the lowest average groundwater level was in 2005 (Figure 9).

Figure 9. Average groundwater levels (yearly).



If there was a correlation between the precipitation and groundwater then the groundwater should have been going up during these years but instead it was falling. Also, in 2006 the precipitation levels were at the lowest for the studied time frame yet in 2007 the groundwater levels are at their highest level for the time frame. There was no apparent correlation between groundwater levels and precipitation levels with the methodology used in this project. More advanced ArcGIS tools may be able to better display an understanding of the data. An increase in well data would have improved the interpolation of the groundwater levels which would have led to a better analysis of the levels. Other factors no doubt affect groundwater levels such as population growth, land use changes, and pumping levels. Further work would be needed in order to make a better conclusion.

References

PRISM (PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, created 4 Feb 2004)

St. Johns River Water Management District (www.sjrwmd.com/gisdevelopment/docs/themes)

U.S. Census Bureau (quickfacts.census.gov)

USGS Groundwater Watch (groundwaterwatch.usgs.gov)