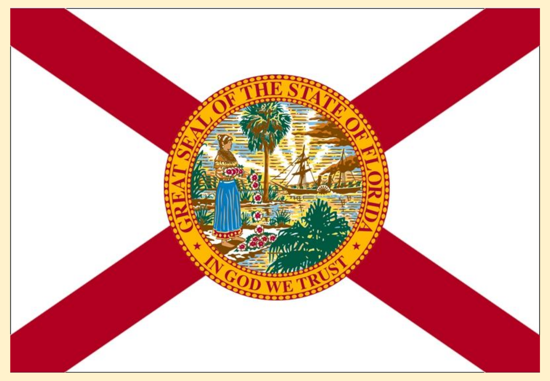

# Analysis of Sinkhole Development in the Floridan Aquifer System


Isaac D. Entz, Michael J. Bair, Neson N. Nesmith

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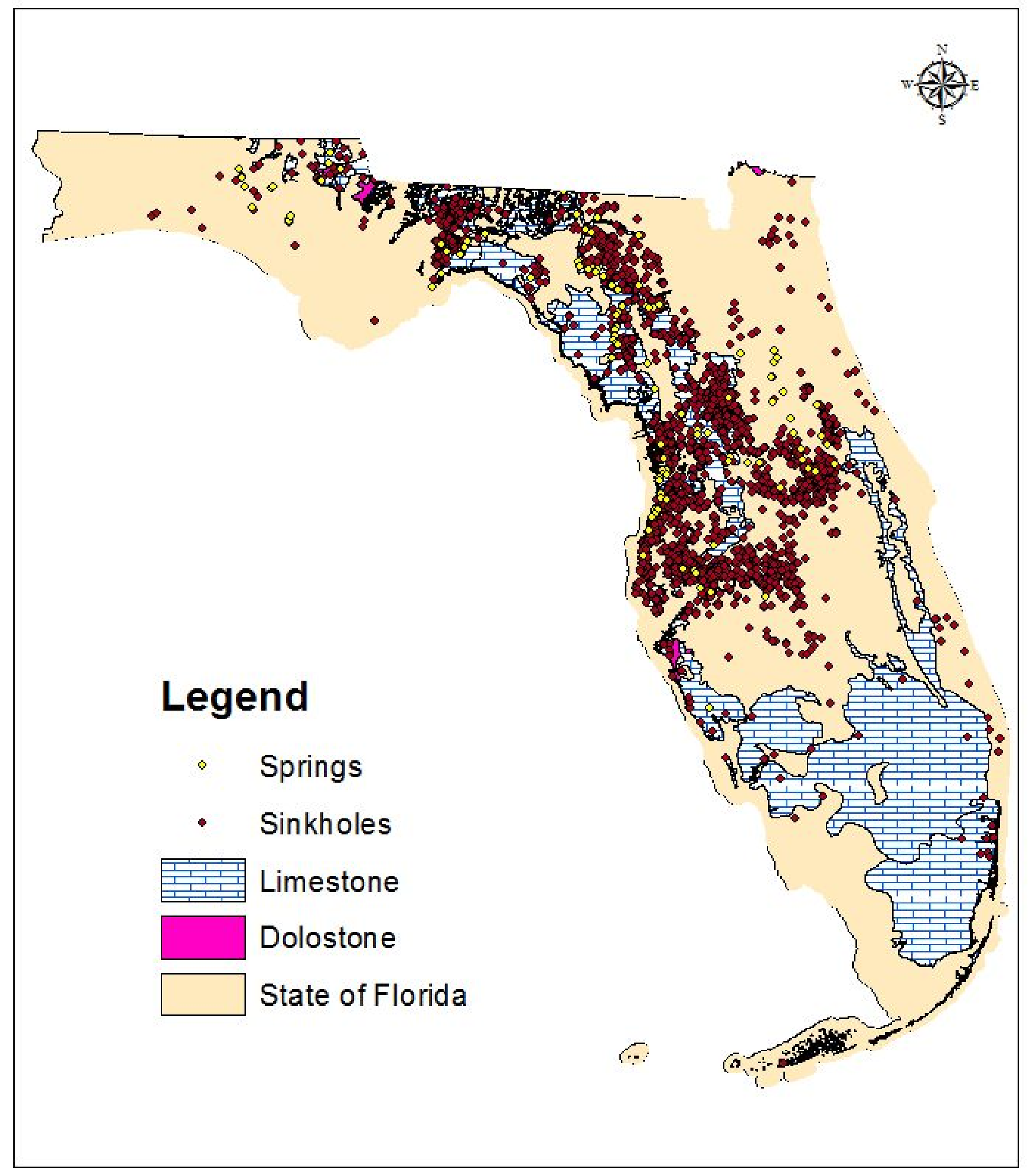
GRAND VALLEY STATE UNIVERSITY


## Introduction

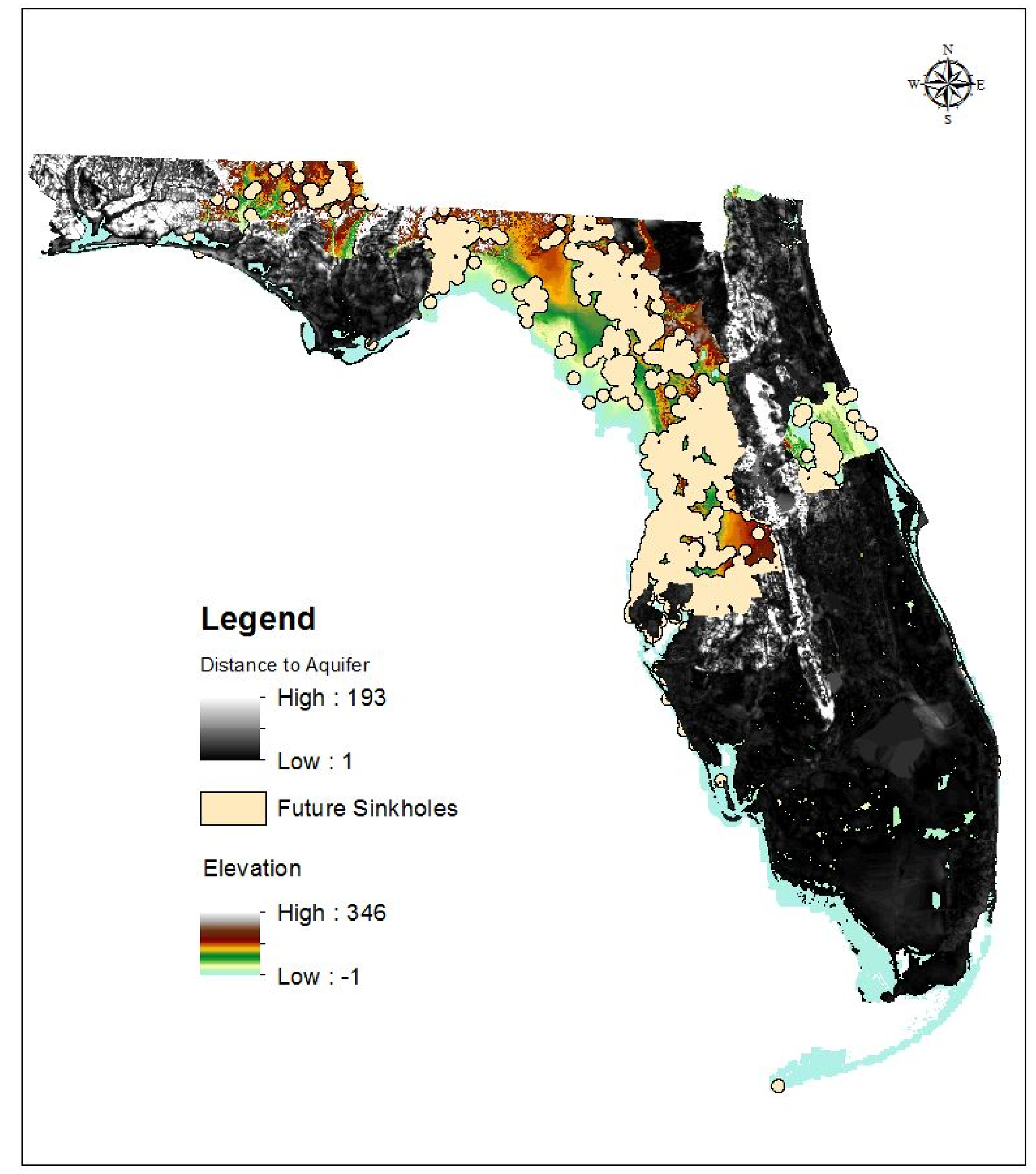
The Floridian Aquifer System (FAS) is one of the most productive aquifers in the world. FAS underlies a surficial area that occupies 100,000 square miles in Alabama, Georgia, Carolina as well as Florida. This research will focuses on the FAS residing only within the state of Florida. The primary bedrock and aquifer geology within the FAS is composed of carbonate material in the form of limestones and dolomite. These sedimentary rock types consist primarily of calcium carbonate ($CaCO3$). Along with having soft material properties, these carbonate rocks are highly susceptible to dissolution by water containing acid ($HCl$). Due to this chemical reaction, the FAS experiences large scale development of sinkholes and freshwater springs. The goal of this research is to illustrate regions, within the FAS, in the state of Florida, that may be more susceptible to sinkhole/spring development in the future.

## Methods

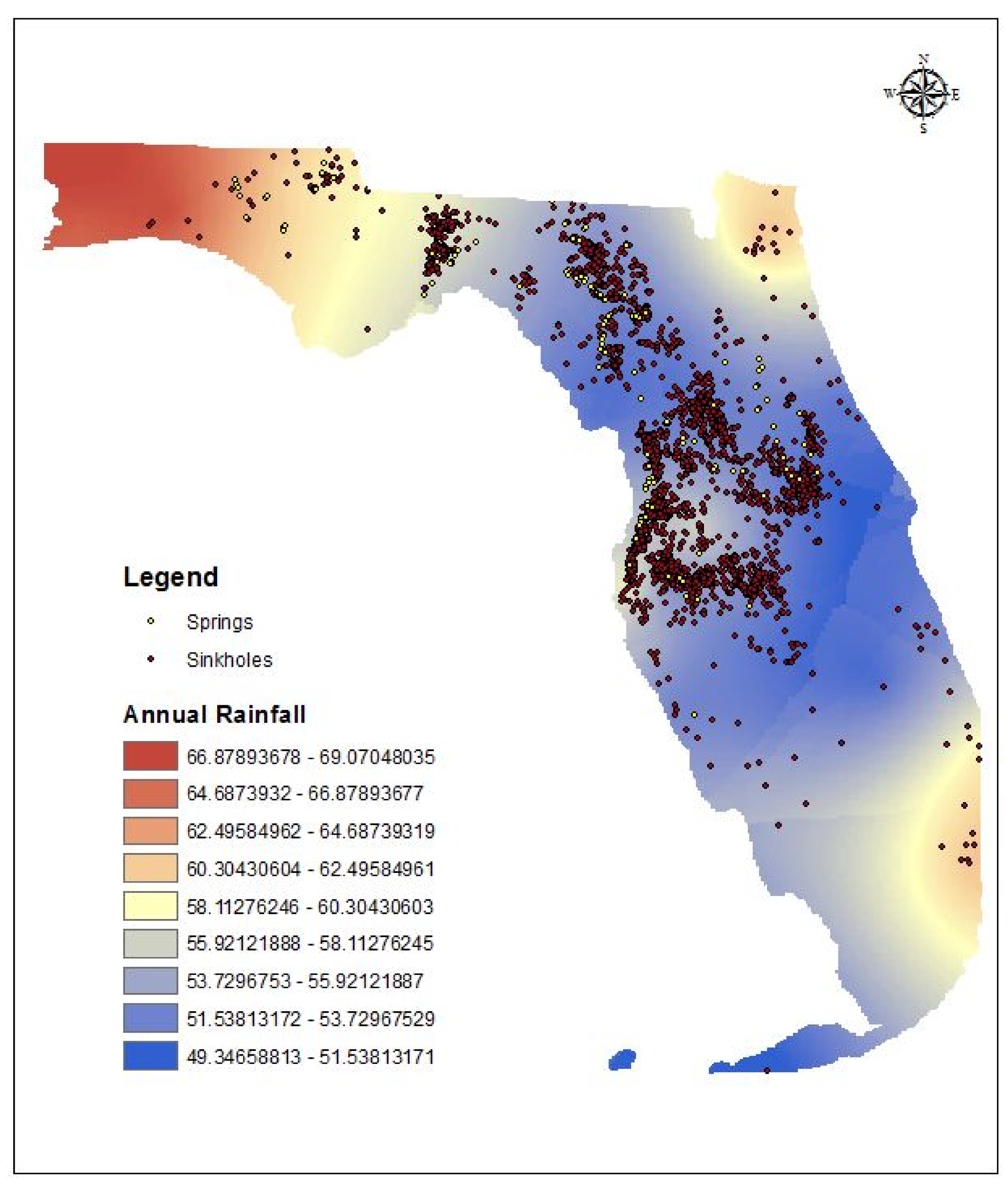
In order to understand the significance and causes of sinkhole development in Florida, maps were created using rainfall, bedrock, elevation, and aquifer data. In order to make the Florida rainfall map, annual rainfall data for 32 cities in Florida were collected from USGS rainfall data and compiled into Excel. Once compiled, the data was converted into a .CSV file and joined to a map of Florida cities. Next, the cities that have rainfall measurements were selected by using select by attributes and were exported into a new layer called Rain_Fall_Gauges. The Rain-_Fall_Gauges layer was then interpolated using the kriging tool. The image produced was then clipped using the analyst and data management tool to produce a raster of rainfall in the shape of Florida. The map depicting the carbonate geology and sinkholes/springs in Florida was created by downloading the geology of Florida from the Florida Geological Survey. Boolean Operations were used in order to separate the dolomite and limestone from other bedrock types. The basemap was produced by using the aggregate polygon function, which merged all of the counties in the state of Florida into one feature. The point features representing springs and sinkholes were applied to this map, as well as to the other three maps. The point locations of these sinkholes and springs were downloaded as a shapefile from the Florida Department of Environmental Protection. The Aquifer elevation map shows the distance to the aquifer from Florida's surface and the elevation of the aquifer (according to sea level). The future sinkhole development map was created by overlaying the Florida state DEM, the depth to aquifer raster, and the spring and sinkhole point data. The final layer was created by applying a buffer of 5000 meters to the sinkhole point features to represent regions of future sinkhole development. The distance to aquifer layer was placed on top to limit the buffer to the region of high correlation.



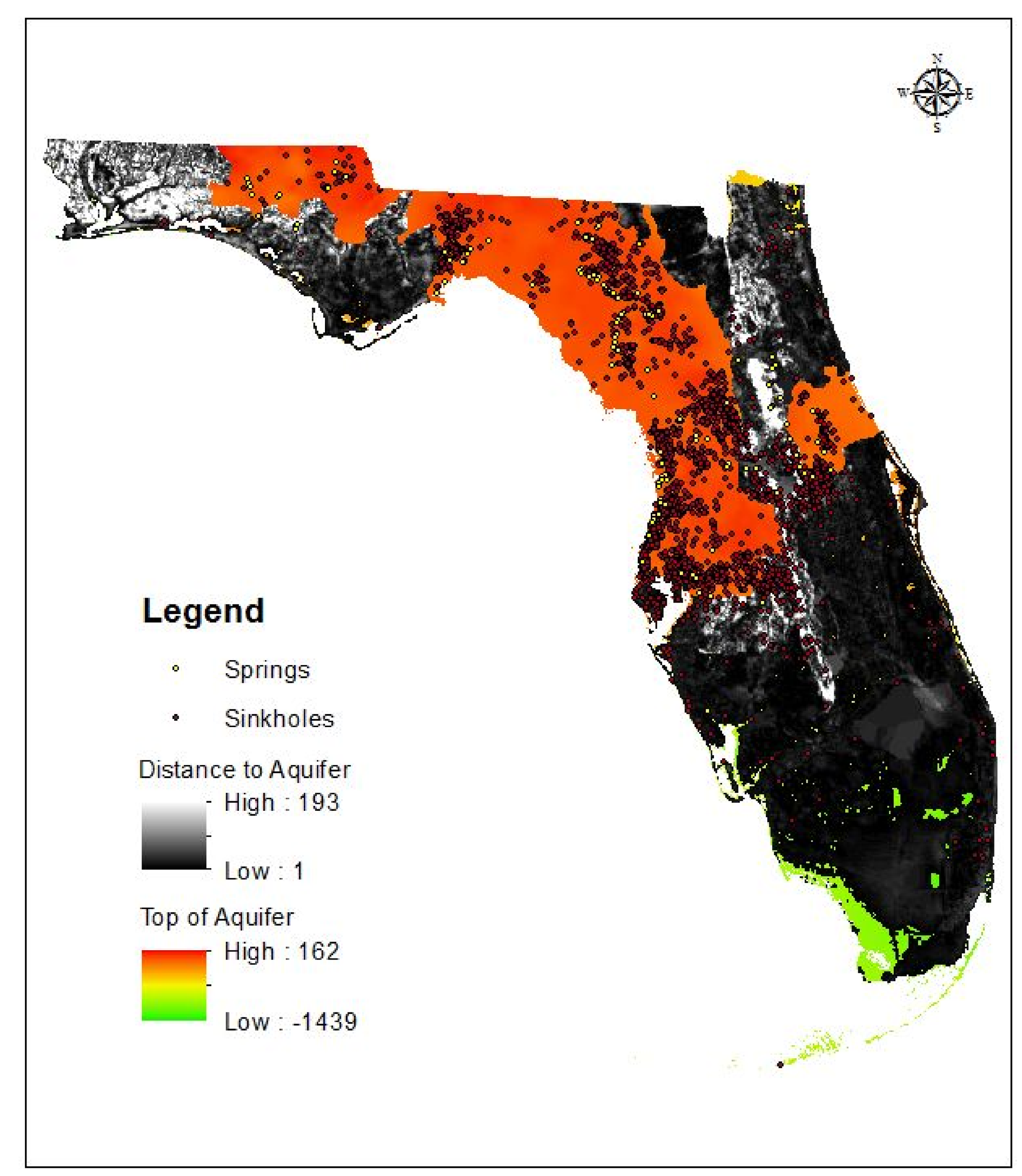

Springs and Sinkholes Overlaying Dolostone and Limestone




Future Sinkhole Developement in Florida




Springs and Sinkholes Versus Annual Rainfall (Continuous)




Springs/Sinkholes Correlation With Aquifer Elevation

## Results

The results of this research display a striking correlation between the location of known sinkholes and springs with the midwestern region of Florida. Where there was shown to be a small distance between the surface and the top of the aquifer, there was an increase in sinkhole development. There was a medium to high correlation of dolostone and limestone with sinkholes, as nearly half of the carbonate material in the region (south) showed almost zero sinkhole development. However, where there were sinkholes, there were also carbonates. Areas of high precipitation seemed to not contain many sinkholes. Most of the sinkholes were found in areas of medium to low precipitation, but most likely high runoff. The highest concentration of sinkholes are found almost exclusively in the red/orange region, which displays both high surface and aquifer elevations. The final map displays the areas that were determined to be most at risk for future sinkhole development. This area is located on the midwestern side of Florida, where the FAS is closest to the surface and the high-to-valley topography allows acidic water to more easily seep down into the aquifer.

## Conclusion

Future sinkhole development will most likely occur in midwestern Florida, where the aquifer is nearest to the surface, geologic material is mostly carbonaceous, surface elevations are high to low with valleys/lowlands, and runoff is abundant. Because sinkholes and springs mostly cluster in high density areas, the 5,000 meter buffer accurately fits a future projection of sinkhole development in midwestern Florida.

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