Floridan Aquifer System Vulnerability Assessment Phase II

Michael Sole, Secretary

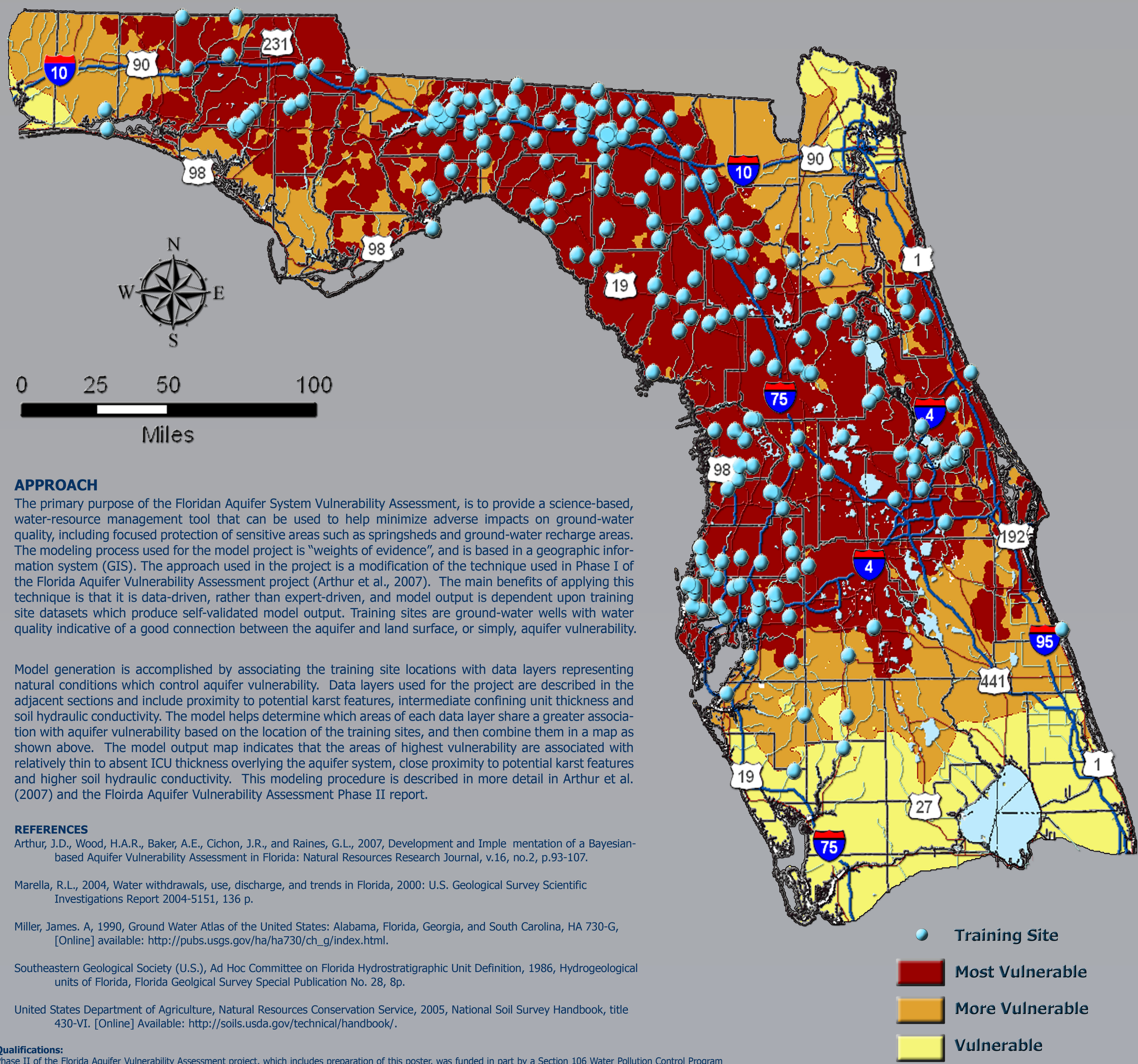
Jonathan Arthur
State Geologist and Director

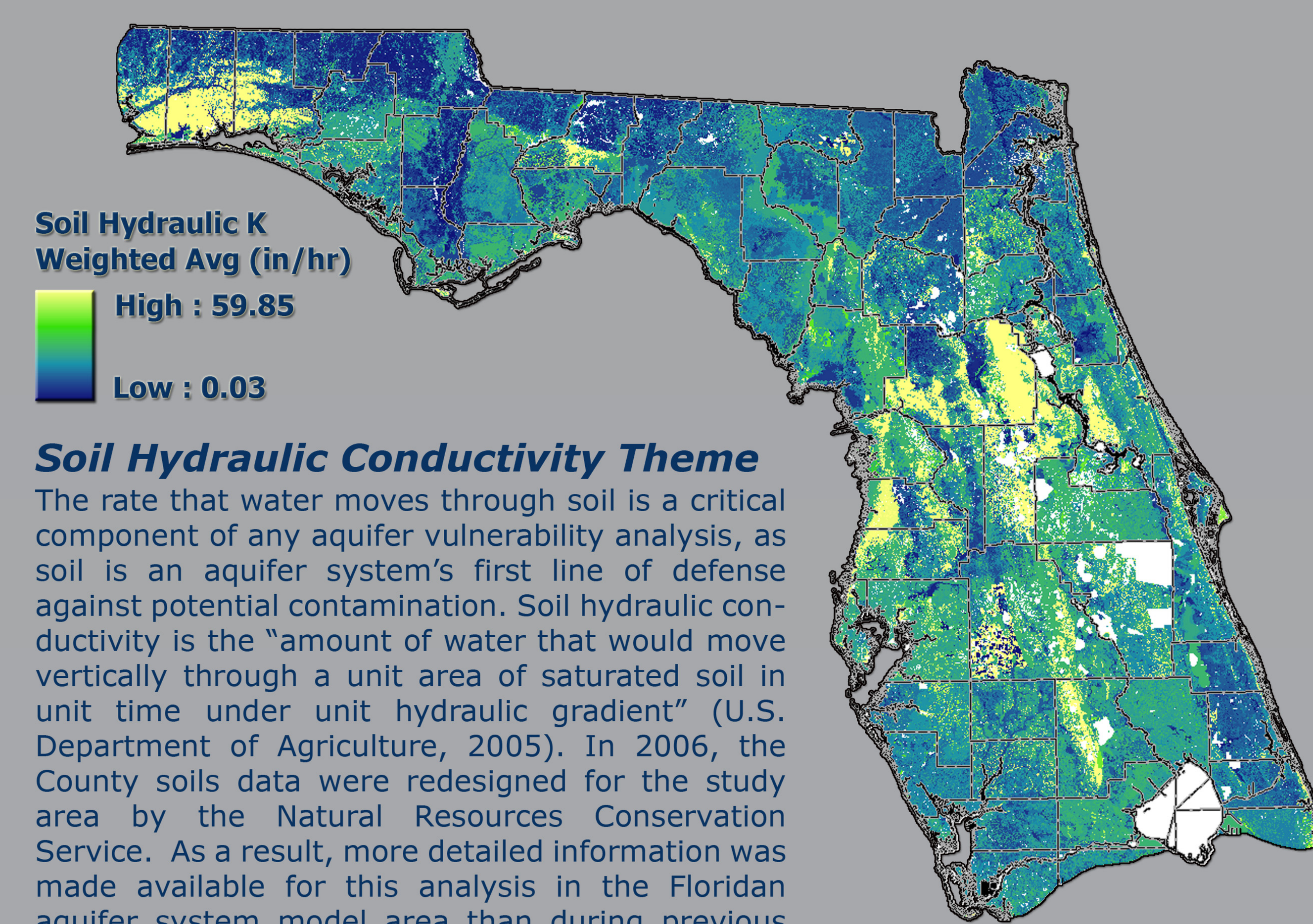
INTRODUCTION

The Floridan aquifer system (FAS) comprises a thick sequence of carbonate rocks which function regionally as a major aquifer system. It ranges from a fully-confined aquifer system where overlain by the IAS to an unconfined aquifer system in areas where it is at or near land surface. The FAS extends throughout the entire State of Florida, however, in the southern peninsula and western panhandle, it is not used as a source of public water supply due to high salinity in the aquifer (Southeastern Geological Society, 1986). It is a major source of ground water for a large portion of the population. Floridians withdrew approximately 3 billion gallons of water per day from the Floridan aquifer system in 2000 (Marella, 2004).

The extent of the FAS used for input into the FAVA model was based on the distribution of FDEP public water supply wells. FDEP wells were plotted in a GIS with a 20-km buffer to develop a study area extent for the FAS.

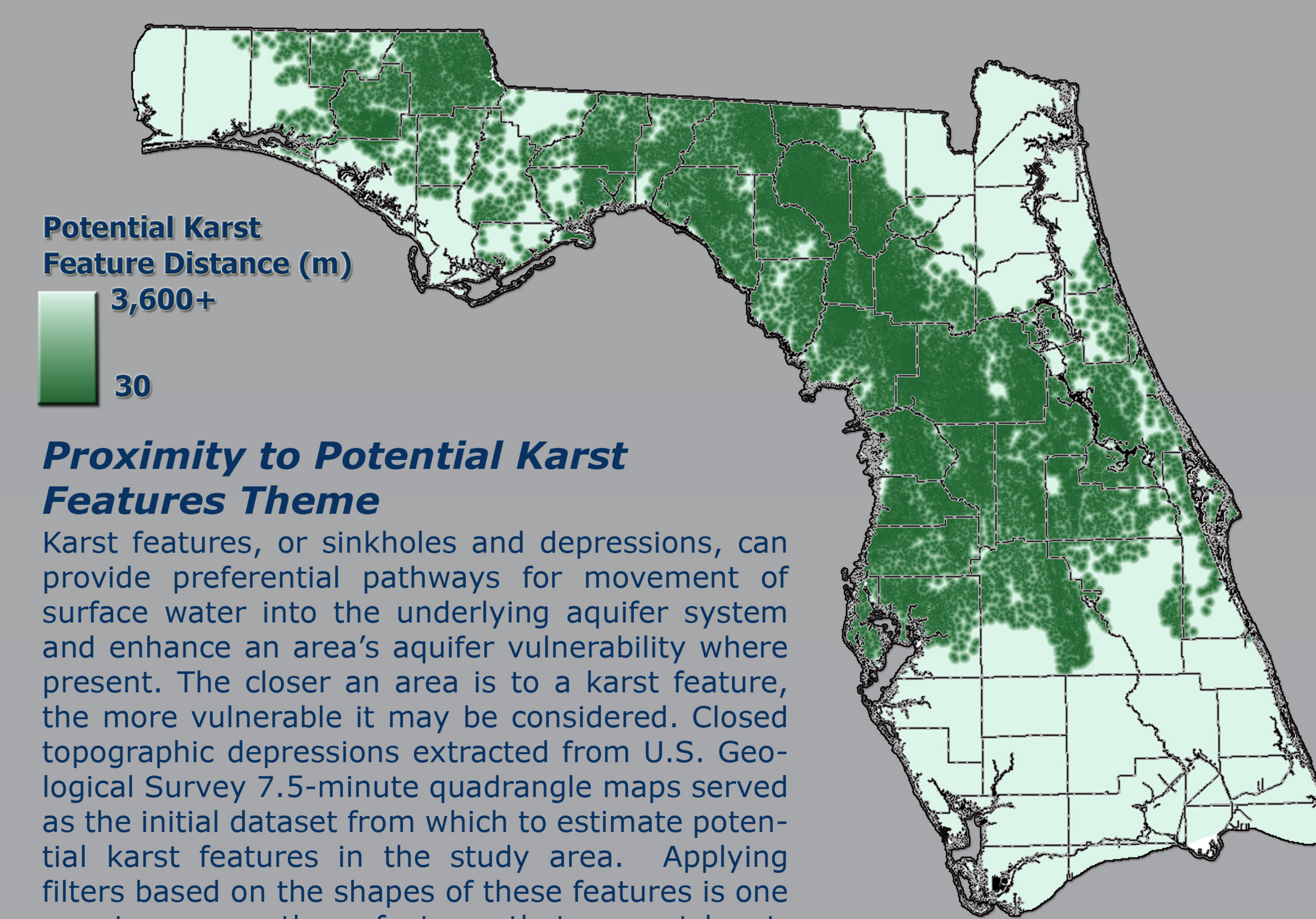
Identifying areas where the Floridan aquifer system is more vulnerable to contamination from activities at land surface is a critical component of a comprehensive groundwater management program. Protection of the area's aquifer systems is an important measure to take in helping ensure viable, fresh water is available to the residents of the area from the region's aquifer systems for continued future use in south Florida. Aquifer vulnerability modeling allows for a pro-active approach to protection of aquifer systems, which can save significant time and increase the value of protection efforts.





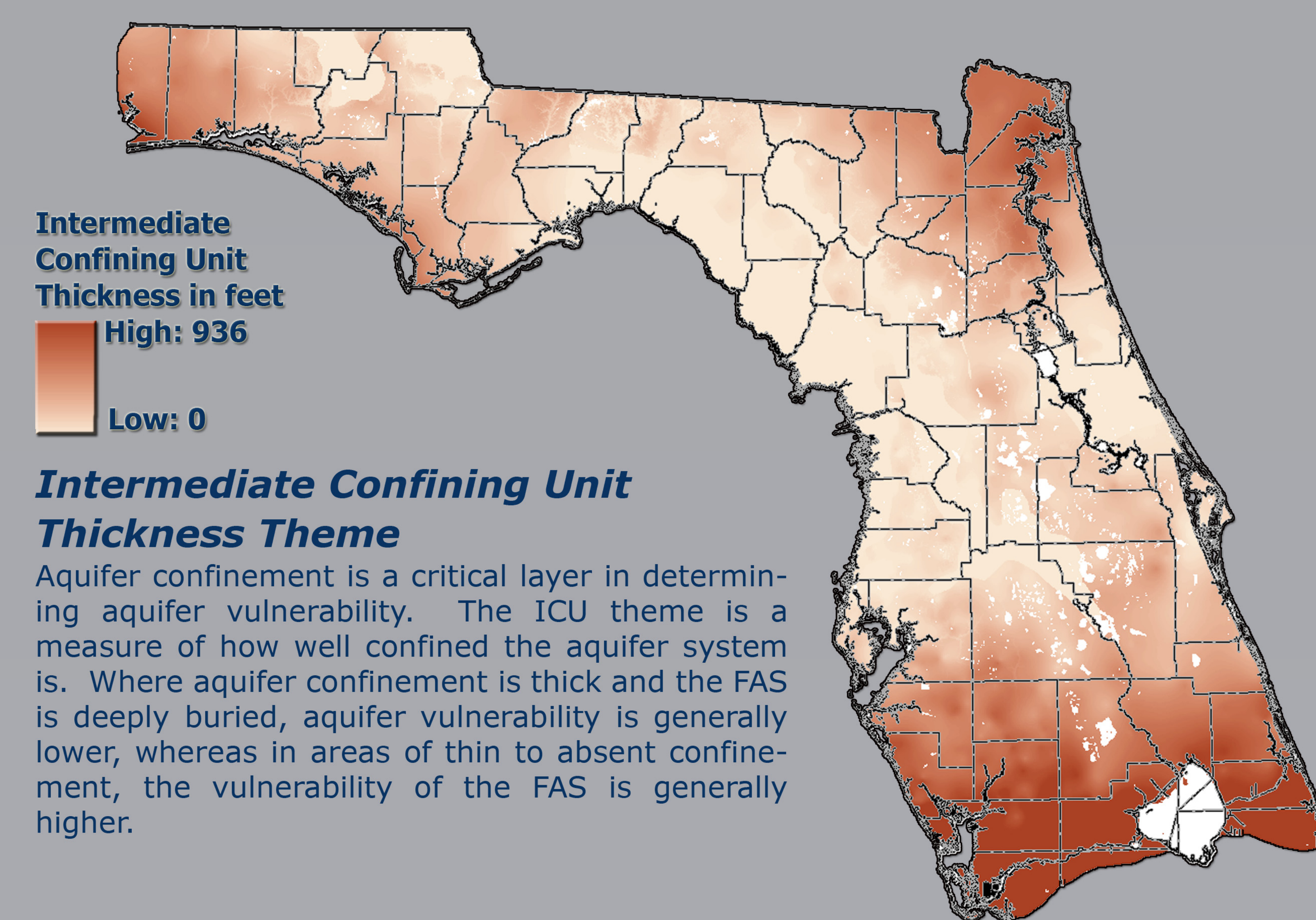
Soil Hydraulic Conductivity Theme

The rate that water moves through soil is a critical component of any aquifer vulnerability analysis, as soil is an aquifer system's first line of defense against potential contamination. Soil hydraulic conductivity is the "amount of water that would move vertically through a unit area of saturated soil in unit time under unit hydraulic gradient" (U.S. Department of Agriculture, 2005). In 2006, the County soils data were redesigned for the study area by the Natural Resources Conservation Service. As a result, more detailed information was made available for this analysis in the Floridan aquifer system model area than during previous projects.



Proximity to Potential Karst Features Theme

Karst features, or sinkholes and depressions, can provide preferential pathways for movement of surface water into the underlying aquifer system and enhance an area's aquifer vulnerability where present. The closer an area is to a karst feature, the more vulnerable it may be considered. Closed topographic depressions extracted from U.S. Geological Survey 7.5-minute quadrangle maps served as the initial dataset from which to estimate potential karst features in the study area. Applying filters based on the shapes of these features is one way to remove those features that are not karst. These resulting closed depression features can be buffered into 30-m zones to allow for a proximity analysis.



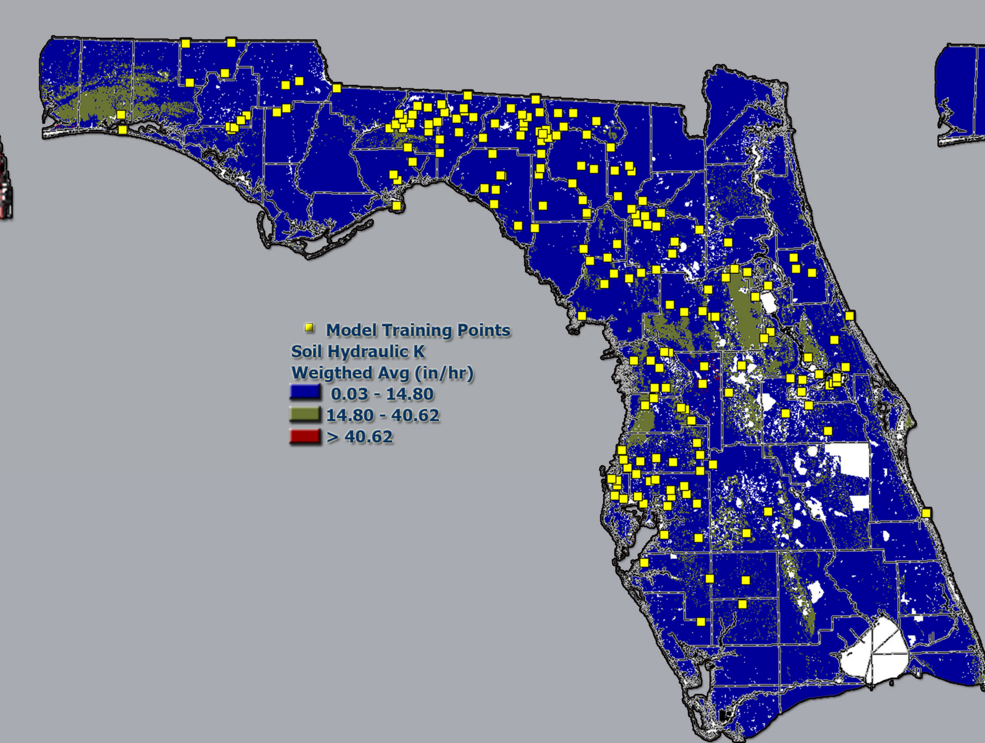
Intermediate Confining Unit Thickness Theme

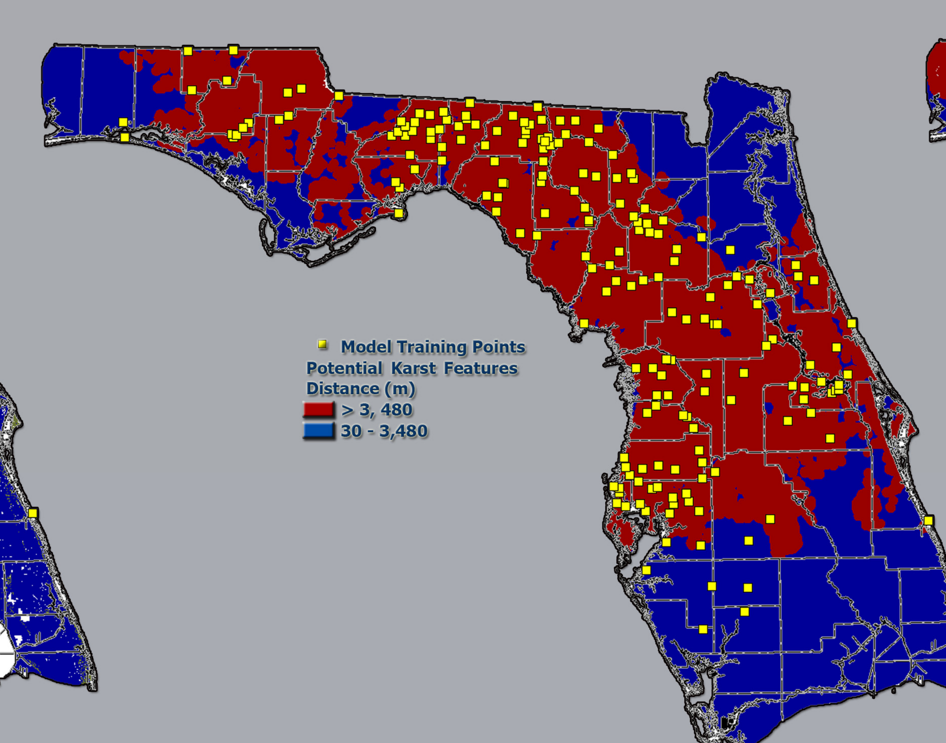
Aquifer confinement is a critical layer in determining aquifer vulnerability. The ICU theme is a measure of how well confined the aquifer system is. Where aquifer confinement is thick and the FAS is deeply buried, aquifer vulnerability is generally lower, whereas in areas of thin to absent confinement, the vulnerability of the FAS is generally higher.

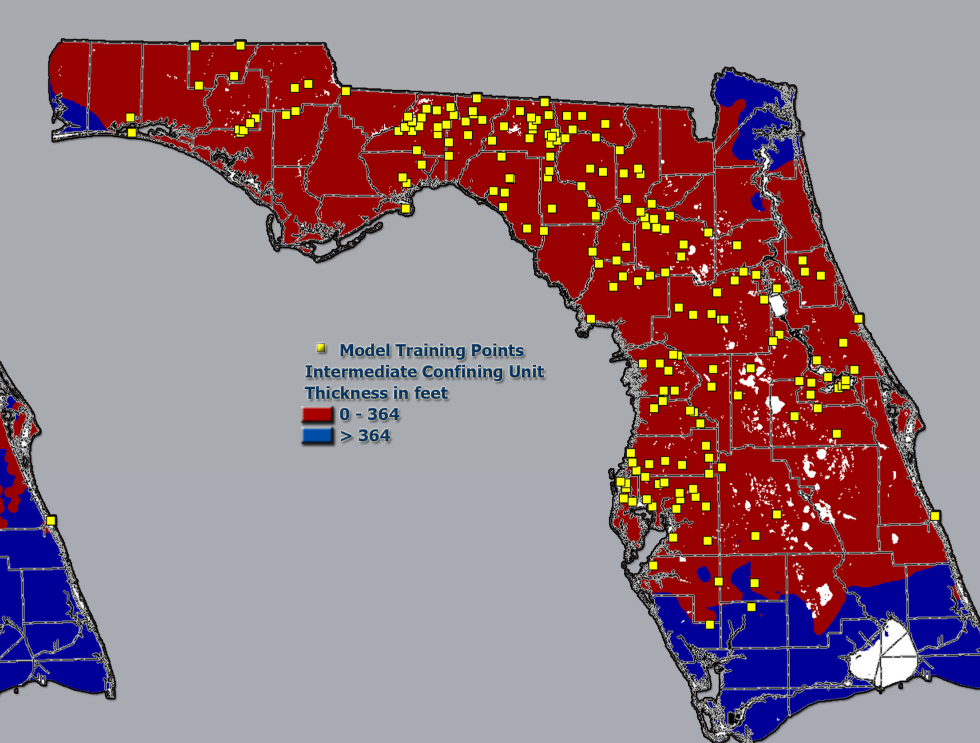
Generalization of Input Data

The modeling process involves generalizing input layers to evaluate which areas of each data layer share a greater association with locations of training sites, or, simply, aquifer vulnerability. Essentially, this process helps to determine the threshold or thresholds that maximize the spatial association between the patterns in the input data layers and the training sites pattern. For the intermediate aquifer system model, a binary break was typically defined by the modeling analysis for each data layer which creates two spatial categories: one with stronger association with the training points and one with weaker association.

Soil Hydraulic Conductivity ranges from 0.03 to 59.85 in/hr) across the study area. Modeling indicated that areas underlain by soils with a hydraulic conductivites higher than 40.62 were more associated with higher aquifer vulnerability. Areas underlain by soils with hydraulic conductivites between 14.80 - 40.62 are moderately associated with aquifer vulnerability and values below 14.80 are less associated with aquifer vulnerability. The ICU thickness ranges from 0 to 936 feet thick thick across the study area, and the analysis revealed that areas with less than 364 feet of ICU were more associated with higher aquifer vulnerability. Finally, the analysis indicated that areas within 3,480 meters of a potential karst feature were more associated with higher aquifer vulnerability. These generalized themes are used to generate the final model output as shown to the left.







APPROACH

The primary purpose of the Floridan Aquifer System Vulnerability Assessment, is to provide a science-based, water-resource management tool that can be used to help minimize adverse impacts on ground-water quality, including focused protection of sensitive areas such as springsheds and ground-water recharge areas. The modeling process used for the model project is "weights of evidence", and is based in a geographic information system (GIS). The approach used in the project is a modification of the technique used in Phase I of the Florida Aquifer Vulnerability Assessment project (Arthur et al., 2007). The main benefits of applying this technique is that it is data-driven, rather than expert-driven, and model output is dependent upon training site datasets which produce self-validated model output. Training sites are ground-water wells with water quality indicative of a good connection between the aquifer and land surface, or simply, aquifer vulnerability.

Model generation is accomplished by associating the training site locations with data layers representing natural conditions which control aquifer vulnerability. Data layers used for the project are described in the adjacent sections and include proximity to potential karst features, intermediate confining unit thickness and soil hydraulic conductivity. The model helps determine which areas of each data layer share a greater association with aquifer vulnerability based on the location of the training sites, and then combine them in a map as shown above. The model output map indicates that the areas of highest vulnerability are associated with relatively thin to absent ICU thickness overlying the aquifer system, close proximity to potential karst features and higher soil hydraulic conductivity. This modeling procedure is described in more detail in Arthur et al. (2007) and the Floirda Aquifer Vulnerability Assessment Phase II report.

REFERENCES

Arthur, J.D., Wood, H.A.R., Baker, A.E., Cichon, J.R., and Raines, G.L., 2007, Development and Imple mentation of a Bayesian-based Aquifer Vulnerability Assessment in Florida: Natural Resources Research Journal, v.16, no.2, p.93-107.

Marella, R.L., 2004, Water withdrawals, use, discharge, and trends in Florida, 2000: U.S. Geological Survey Scientific Investigations Report 2004-5151, 136 p.

Miller, James. A, 1990, Ground Water Atlas of the United States: Alabama, Florida, Georgia, and South Carolina, HA 730-G, [Online] available: http://pubs.usgs.gov/ha/ha730/ch_g/index.html.

Southeastern Geological Society (U.S.), Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition, 1986, Hydrogeological units of Florida, Florida Geolgical Survey Special Publication No. 28, 8p.

United States Department of Agriculture, Natural Resources Conservation Service, 2005, National Soil Survey Handbook, title 430-VI. [Online] Available: http://soils.usda.gov/technical/handbook/.

Qualifications:

Phase II of the Florida Aquifer Vulnerability Assessment project, which includes preparation of this poster, was funded in part by a Section 106 Water Pollution Control Program grant from the U.S. Environmental Protection Agency (US EPA) through a contract with the Florida Department of Environmental Protection/Florida Geological Survey (FDEP/FGS). The total cost of Phase II of the FAVA project was $234,899, of which 11% was provided by the US EPA.

This poster is developed as part of Florida Aquifer Vulnerability Assessment (FAVA) Phase II for the Florida Department of Environmental Protection/Florida Geological Survey per FDEP/FGS Contract No. RM059. Version 1.0: August 31, 2009. The vulnerability map accompanies "The Florida Aquifer Vulnerability Assessment Report (FAVA) Phase II" prepared by Alan E. Baker, P.G. 2324, and James R. Cichon of Advanced GeoSpatial Inc.;
FAVA Phase II project managers are Allan Stodghill, P.G. (FDEP), Division of Water Resource Mangement and Rick Copeland, Ph.D., P.G., FDEP/FGS.