

Sinkholes are a common geological feature in Karst geological formation, which occupies 25% of the United States geology, and nearly 20% of the nation's terrain is subject to sinkhole events. Sinkholes are one of the predominant landforms in Florida and the southeastern region, and there are various economic and environmental problems associated with sinkholes. For example, sinkholes can cause the problems of stream and swamp running dry, and interaction between groundwater and surface water through sinkholes may increase the risk of aquifer contamination from surface water drainage. These problems pose great challenges to integrated surface/groundwater management and long-term sustainability of water resources and ecosystems.

Among the three types of sinkholes (dissolution, cover-subsidence, and cover-collapse), the cover-collapse sinkholes are the most dangerous, because they occur abruptly and cause catastrophic damages such as casualty, injury, and property damage. Sinkhole damages are the highest in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. Taking Florida as an example, a Tampa resident vanished into a sinkhole that opened up under his bedroom on a night in March, 2013. In the last several years, sinkholes have become Florida's insurance disaster due to sinkhole collapse in urban areas. There is an urgent need for research to understand sinkhole development and catastrophic collapse.

Water is one of the primary triggering mechanisms for sinkhole collapse, and hydrogeology plays a critical role in sinkhole development. However, the hydrogeology community faces the difficulty of lacking the capability to quantitatively simulating how sinkholes develop and when and where they collapse. This is attributed to the situations that groundwater modeling for Karst media is still in its development stage and that sinkhole modeling is interdisciplinary, requiring integrated study of hydrogeology, soil/rock mechanics, geography, computational sciences, and applied mathematics. Due to the lack of mathematical and numerical models, there have been few attempts to estimate parameters that characterize controlling factors of sinkhole development and collapse, especially at a large scale such as the basin scale.

The **goal** of this project is two-fold: (1) to gain fundamental understanding of sinkhole development and catastrophic collapse through laboratory experiments and field investigations, and (2) to develop mathematical models and computational codes for simulating sinkhole phenomena in a forecast context. We expect to make significant advances in the following critical areas: (1) Understanding impacts of controlling factors (e.g., geology, hydrology, and soil mechanics) and their interactions on sinkhole development and catastrophic collapse at the laboratory and field scales, (2) Developing and validating mathematical models and numerical codes that simulate coupled water movement and sediment transport in a subsurface system with porous media (saturated and unsaturated soils and aquifers) and Karst media (conduit and cavity), (3) Identifying controlling factors and estimating their characterizing parameters by using experimental and modeling approaches for the Peace River basin where a large amount of data have been collected by USGS Tampa office and the Lake Oak site where Florida Geological Survey is conducting pilot field investigations, and (4) Delineating vulnerability and risks of sinkhole collapse by using the process-based models and multivariate geographic regression methods for establishing guidelines of water resource management and land-use planning.

This project is interdisciplinary and multi-institutional in nature. The project team consists of a hydrogeologist, an applied mathematician, two graduate students (one is a Fulbright Scholar from Mexico), and an undergraduate student. This project team will collaborate with scientists from U.S. Geological Survey, the Florida Geological Survey, and the Geophysical Fluid Dynamics Institute at the Florida State University.