

PROJECT SUMMARY

Overview:

This RAPID proposal explores the possibility of turning sinkhole geohazards into a research opportunity for advanced understanding of groundwater and surface water interaction through sinkholes in karst areas. In the week of 1/23/2018, two sinkholes were exposed in Lake Miccosukee, and part of the 6,257-acre lake has disappeared due to lake water drainage through the sinkholes into the underlying upper Floridan aquifer. The continuous drainage of a large amount of lake water and water-contained contaminants into sinkholes can be viewed as a natural tracer experiment. It is hypothesized that, if the contaminant concentrations are monitored in downgradient karst springs and rivers, the sinkhole geohazard can be turned into a knowledge gain of karst hydrogeology and solute transport. Considering the long period and large amount of lake drainage, it is further hypothesized that sinkhole-caused natural tracer experiments may be more effective than man-made dye tracer experiments for karst research. To test these hypotheses, it is necessary to immediately conduct a dye tracer experiment at the open sinkholes, and to launch a timely data collection campaign for collecting water and sediment samples in the lake and downgradient upper Floridan aquifer, karst springs, spring runs, and rivers. The opportunity window for the proposed research activities is not wide for two reasons: (1) the sinkholes may be quickly clogged by sediments or covered by lake water after rainfalls, and (2) the drained lake water and contaminants may be discharged into downgradient karst springs in several weeks given the fast flow velocity in karst conduits that connect the sinkholes and karst springs. These are the reasons of submitting this RAPID proposal so that timely investigations can begin as soon as possible to turn the sinkhole geohazards into knowledge of hydrologic systems. The collaboration with the Florida Geological Survey will give the proposed research activities a jump-start.

Intellectual Merit:

Although lake sinkhole events have occurred multiple times in the past, there has been no timely effort to collect water quality data during and after the events. The proposed data collection campaign will enable us to gain insights on the hydrologic and biogeochemical relations between lake water, groundwater, spring water, and river water. These relations are largely unknown, but indispensable to answer a number of scientific questions related to groundwater and surface water interaction, groundwater flow pattern, travel time, karst heterogeneity, and groundwater chemistry. On the other hand, conducting dye tracer experiments at open lake sinkholes has not been attempted, while conducting dye tracer experiments at terrestrial sinkholes is common. The hydrologic conditions at the Miccosukee sinkholes make it possible to conduct a dye tracer experiment at open lake sinkholes, a unique opportunity presented by the lake sinkhole events for evaluating the value of information and knowledge gained during and after the proposed dye tracer experiment. The proposed dye tracer experiment may set a pilot example for similar experiments in the future.

Broader Impacts:

Sinkholes are a common geological feature in karst formation that occupies 25% of the United States geology. According to the U.S. Geological Survey, about 20% of the nation's terrain is subject to sinkhole events. Sinkholes have caused various environmental, economic, social, and infrastructural problems in Florida and the southeastern region, where sinkholes are one of the predominant landforms. Sinkholes pose great challenges to management of surface and groundwater and to long-term sustainability of water resources and ecosystems. The challenges may be intensified due to climate changes, population increase, and land use changes. This project studies sinkholes' environmental impacts on water quality, and explores the possibility of turning sinkhole geohazards into a research opportunity for knowledge gain. The research methods developed in the study can be applied to many other sites in Florida and other states of karst terrain. By collaborating with the Florida State Geological Survey, the research results will be delivered to state government agencies of water resources and environmental managements. Research results will also be presented at national and international conferences, and available in the public domain. The research will be incorporated into STEM education through environmental curricula and training of a graduate student, who will be recruited from underrepresented groups.