Sinkholes are natural geohazard phenomena that cause damage to property and may lead to loss of life. They can also cause added pollution to the aquifer by draining unfiltered water from streams, wetland, and lakes into the aquifer. Sinkholes occur in a very distinctive karst geology where carbonate, limestone, dolomite, or gypsum, are encountered as the bedrock that can naturally be dissolved by groundwater circulating through them. Sinkholes can occur gradually or suddenly with catastrophic impact depending on the geology and hydrology of the area. Predicting the formation and the collapse of a sinkhole based on the current ground investigation technologies is limited by the high levels of uncertainties in the soil properties and behavior. It is possible that progressing sinkholes can be missed by geotechnical site investigations especially during the development of a very wide area. In this study, a laboratory-scale sinkhole model was constructed to physically simulate the sinkhole phenomenon. The physical model was designed to monitor a network of groundwater table over time around a predetermined sinkhole location. This model was designed to establish a correlation between the groundwater table fluctuation and the sinkhole development. The experimental small-scale model showed that there is a groundwater cone of depression that forms prior the surface collapse of the sinkhole. The cone of water depression can be used to identify the potential location of the sinkhole at early stage of the overburden underground cavities formation in a reverse manner. In addition, monitoring of single groundwater well showed that groundwater fluctuation signal has some sudden water drops (progressive drops) which occur at different times (time lags) during the sinkhole development. A time frequency analysis was also used in this study to detect the pattern of these progressive drops of the groundwater table readings. It is observed, based on the model, that the development and growth of sinkhole can be correlated to progressive drops of the groundwater table since the drops start at the monitoring wells that are closer radially to the center of the sinkhole. Subsequently, with time, these drops get transferred to more distant monitoring wells. The time frequency analysis is used to decompose and detect the progressive drops by using a Pattern Detection Algorithm (AMD), which was developed by Yun (2013). The results of this analysis showed that the peaks of these progressive drops in the raw groundwater readings are a good indicator of the potential location of sinkholes at early stage when there are no any visible depression of the ground surface. Finally, the effect of several soil parameters on the cone of the water depression during the sinkhole formation is studied. The parametric study showed that both of overburden soil thickness and the initial (encountered) groundwater table level have a clear impact on the time of the sinkhole collapse.

While this model used a predetermined crack location to study the groundwater level response around it, the concept of groundwater fluctuation as an indicator of sinkhole progression and collapse may be used to determine the ultimate location of the sinkhole. By monitoring the fluctuations in natural groundwater levels in the field from either an existing network of groundwater monitoring wells or additional installation, the methodology discussed in this dissertation may be used for possible foreseeing of the surface collapse of sinkholes.

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