Tran-SET
Transportation Consortium of South-Central States

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Karst Sinkhole Detecting and Mapping Using Airborne LiDAR

Key Points

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18GTUNM01

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University of New Mexico

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$70,000

Funding Source(s):
Tran-SET
University of New Mexico
New Mexico Department of Transportation

Total Project Cost:
$140,000

Brief Project Description

Sinkholes cause subsidence and collapse problems for many transportation infrastructure assets. Subsequently, transportation infrastructure management agencies dedicate a considerable amount of time and money to detect and map sinkholes as part of their infrastructure asset management programs. These collected sinkhole data are used by transportation agencies to determine the extent and severity of the sinkholes, and to make decisions about appropriate actions to avoid potential public safety hazards. Traditionally, sinkhole detection is performed on the ground by having experts visually inspect the condition of the sinkholes. This is an expensive, time-consuming, and labor-intensive method. A recent advance in remote sensing, especially airborne light detection and ranging (LiDAR), allows for the examination of the change in the Earth's surface elevation accurately and rapidly. This study will explore the utility of LiDAR in detecting and mapping the surface expression of sinkholes. Best practices for implementation of a statewide sinkhole hazard management system (SHMS) will also be identified. A guidebook on airborne LiDAR-based sinkhole detection and mapping will also be developed for professional education and training.

Problem Statement

Sinkhole subsidence and collapse is a natural hazard of national scope – sinkholes are found in all 50 states. Man-made infrastructure and buildings and transportation arteries have expanded onto karst terrain that was formerly rural and sparsely developed. Therefore, each year sinkhole hazards cause substantial damages to these infrastructure assets. Repair of sinkhole damages to buildings, highways, and other infrastructure systems represents a significant national cost. Furthermore, because of their sudden appearance and hazardous nature, it is important to distinguish sinkholes' embryonic structure and localize their position at an early stage. Therefore, being able to accurately detect and map existing sinkholes is important for transportation planning and safety as well as infrastructure sinkhole risk assessment, hazard preparedness, and hazard mitigation.

The effectiveness of LiDAR to detect existing sinkholes has received very limited attention. Most of the research on LiDAR-based sinkhole detection postulates that morphological-based surface feature extraction methods can effectively detect sinkholes because of their geometric properties. The

proposed research will use airborne LiDAR data in combination with auxiliary context such as site and association to improve the accuracy of the morphological-based sinkhole detection methods.

Objectives

The proposed study includes three objectives: (1) develop a complete process and toolset for detecting and mapping sinkholes using airborne LiDAR data; (2) identify best practices for implementation of a statewide sinkhole hazard management system (SHMS); and (3) develop a guidebook for LiDAR-based sinkhole detection and mapping for professional education and training. The research objective is to develop an accurate and rapid LiDAR-based sinkhole detection and mapping method and transfer the technologies to transportation engineers for implementation and workforce development.

Intended Implementation of Research

Workforce Development

This study will develop a set of software tools that can be used immediately by state DOTs with the appropriate software to detect and map sinkholes. The research team will promote project-related technologies through three outreach workshops to train transportation professionals in the State of New Mexico to effectively use the developed tools. Through technology implementation, the project team will also identify best practices for implementation of a state-level SHMS. The study also develops a guidebook for LiDAR-based sinkhole detection.

Education

This proposed project will provide funding to University of New Mexico students. Student participation through the development of the sinkhole detection tool and workshops expose students to geospatial technologies and spatial data management, which are already becoming the norm in many government and industry agencies.

Outreach

The project team will create a video-taped workshop that will be web-accessible to the audience with no cost through the New Mexico Resource Geographic Information System Program and Clearinghouse.

Anticipated Impacts/Benefits of Implementation

This research project will explore the utility of LiDAR in detecting and mapping the surface expression of sinkholes. This project will also identify best practices for implementation of a state-level sinkhole hazard management system (SHMS). This project will also develop a guidebook for LiDAR-based sinkhole detection and mapping for professional education and training.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1505457)