Sinkhole Detection, Mapping, and Characterization Using LiDAR-Derived DEM in WINK, Texas

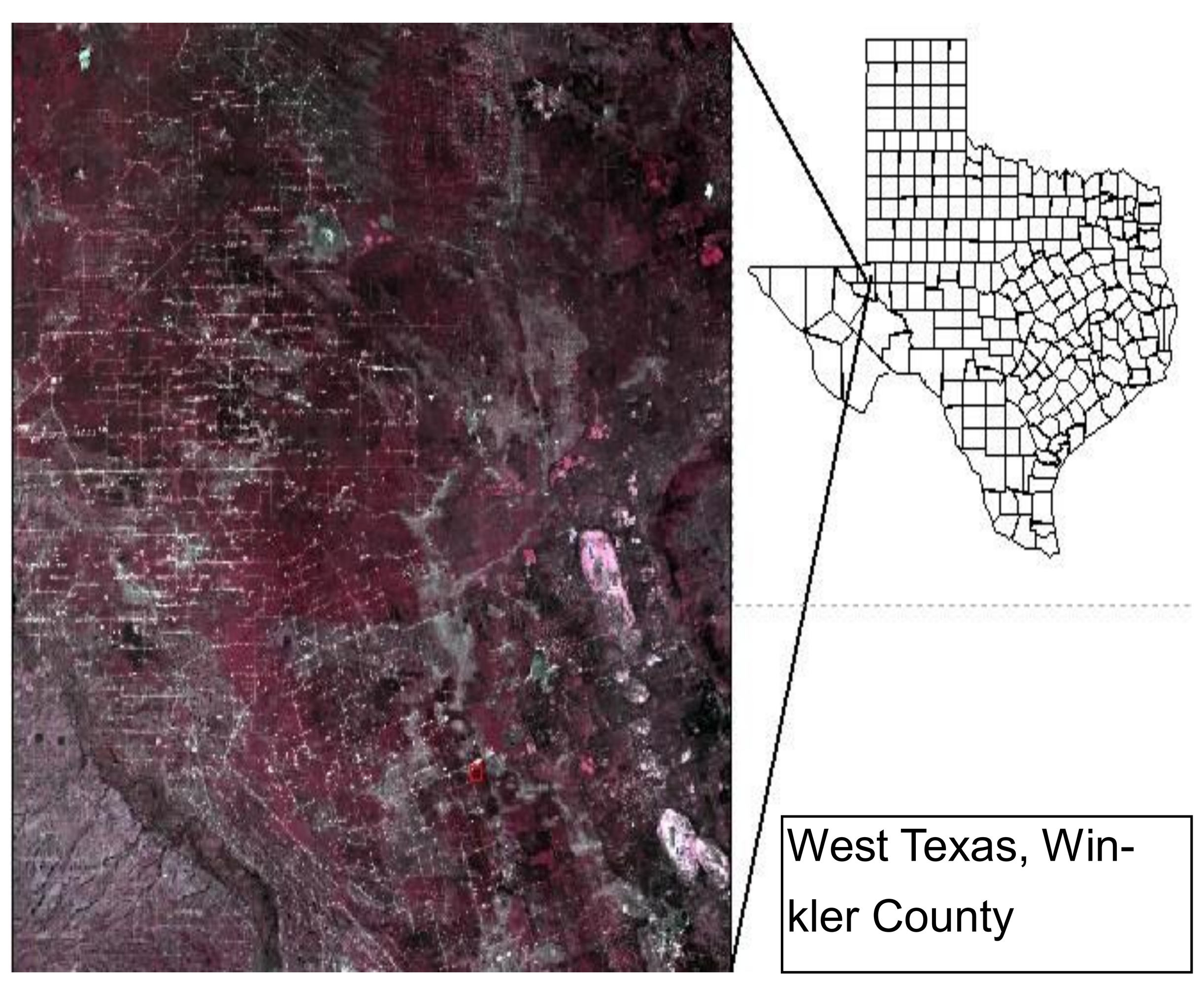
Yosef Darge- MS. Department of Geological Science Faculty Advisor: Dr. Esayas Gebremichael, Department of Geological Science

COLLEGE OF SCIENCE & ENGINEERING
DEPARTMENT OF ENVIRONMENTAL SCIENCES

ABSTRACT

Subsidence is a downward sinking of earth materials that creates a large or small circular surface, but it may produce linear or irregular failure patterns. The highly dissolved calcium carbonate or evaporite rocks allow acidic rainwater to permeate its strata. Near or underlying rock can easily be dissolved in water and create space and caverns underground, making a sudden catastrophic collapse of the land surface. Highly soluble bedrocks are a widespread geologic phenomenon in the West Texas Permian Basin. The majority of the area has been impacted by the subsurface dissolution gypsum layers, which is a cause of the active sinkhole formation from a few meters to 100 m wide. This geohazard has caused damage on infrastructure and civilian property. It can cause environmental problems when it alters the local hydrology. Sinkhole detection using field surveying is expensive, time-consuming, labor-intensive, and not easily accessible, and it might be potentially dangerous for the surveyor. In this paper, I detect, map, and thus analyze anthropogenic triggering factors of sinkholes in Wink, Texas, using open-source high-resolution LiDAR (Light Detection and Ranging) data. Methods involve Generating Digital Elevation Model (DEM), extracting the depressions from DEM, identifying sinkhole boundary contour, and then converting the delineated sinkhole to a polygon shapefile, analyzing the shape and geometric properties. False alarm sinkhole depression eliminates based on the threshold value. Finally, possible sinkholes have been detected

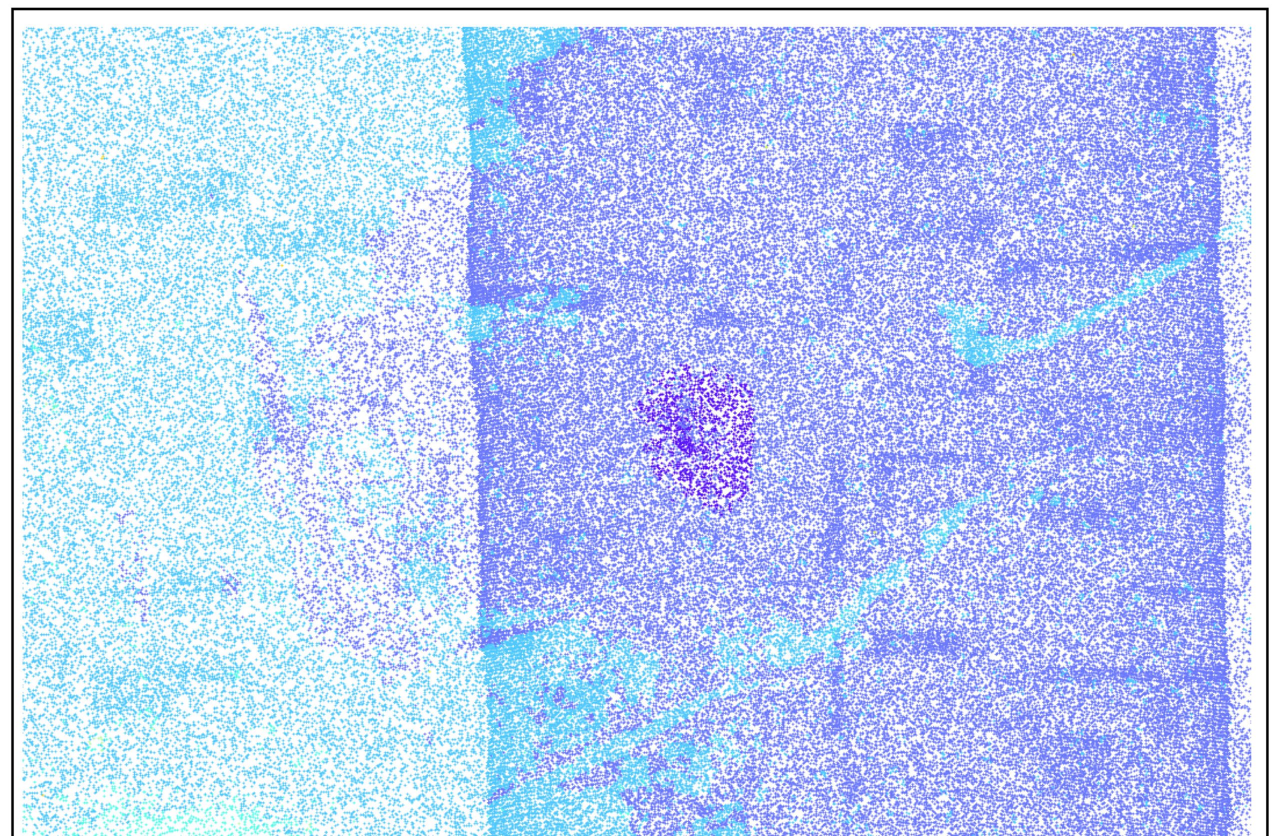
STUDY AREA



OBJECTIVES

Detecting and Mapping of the spatial distribution of sinkholes over the study area .

DATA

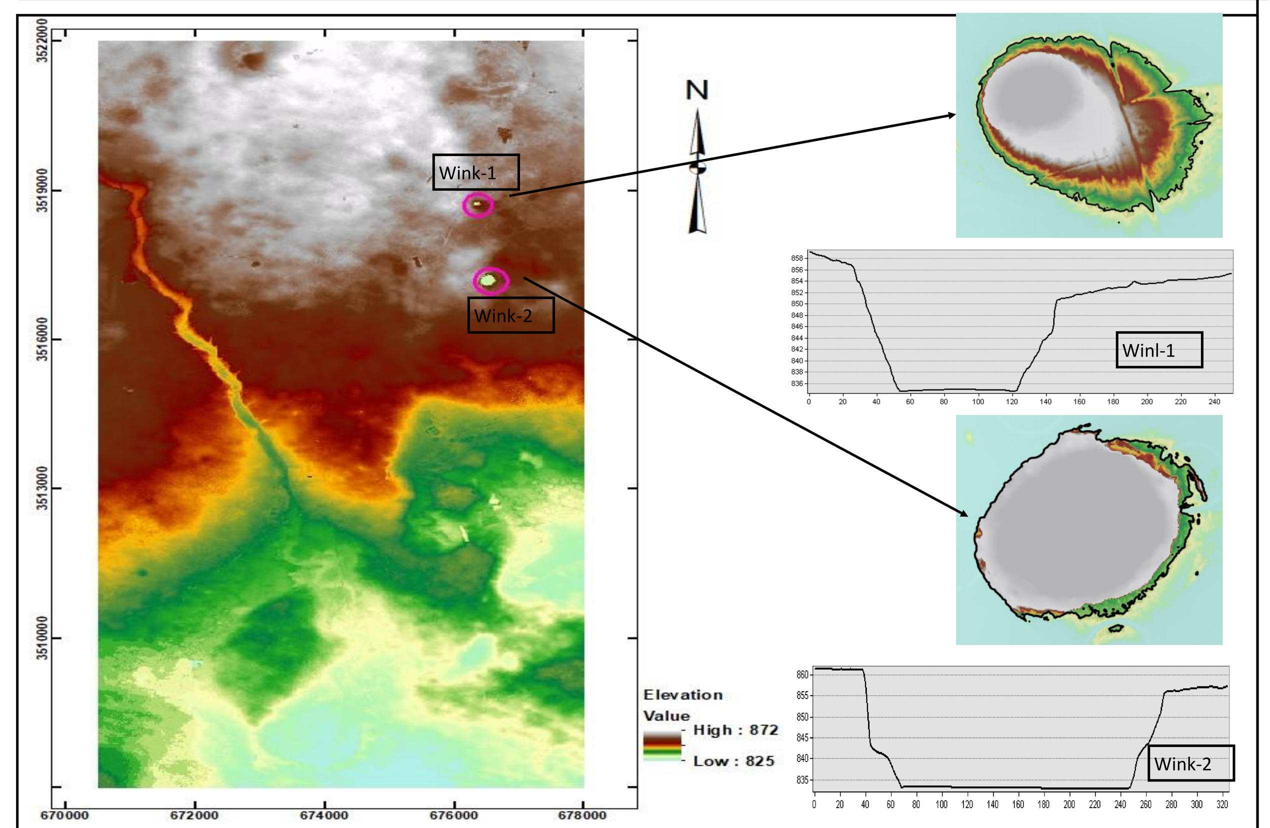


Light Detection and Ranging (LIDAR) is a remote sensing technique that uses pulsed laser light to create three-dimensional topographic models. This study were used point cloud lidar data to generate 1 m resolution Digital Elevation Model .

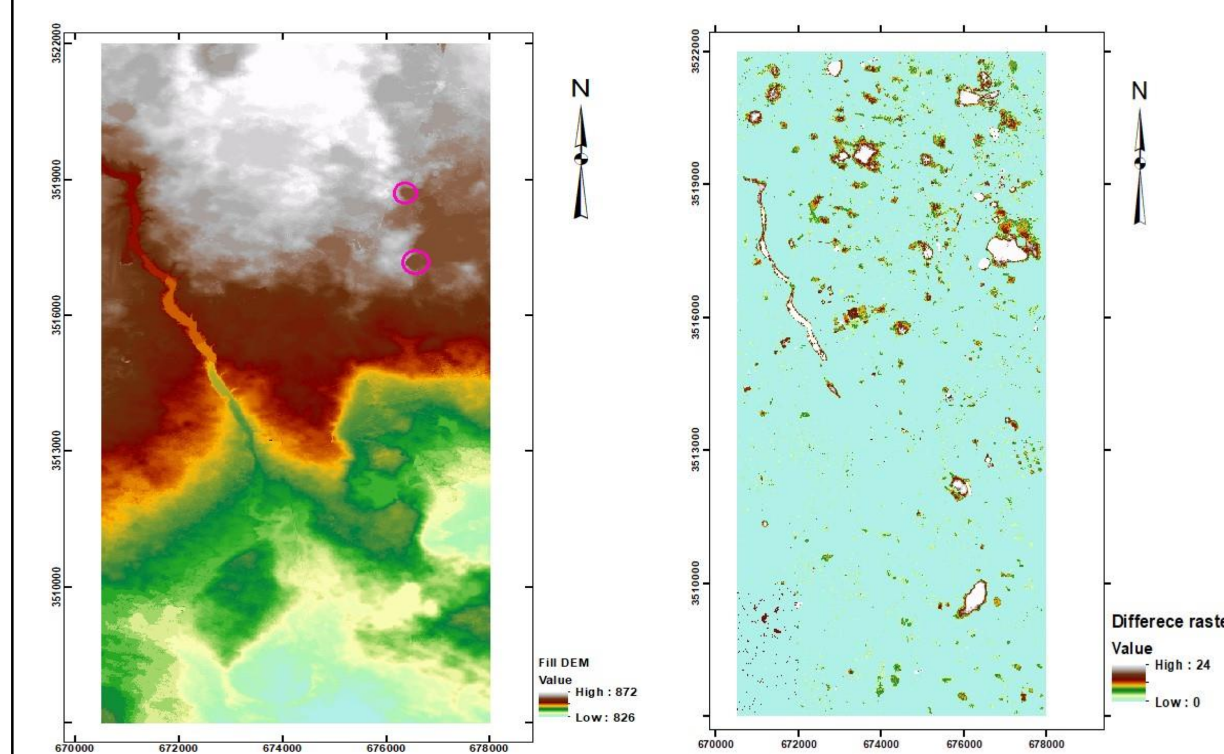
METHODOLOGY

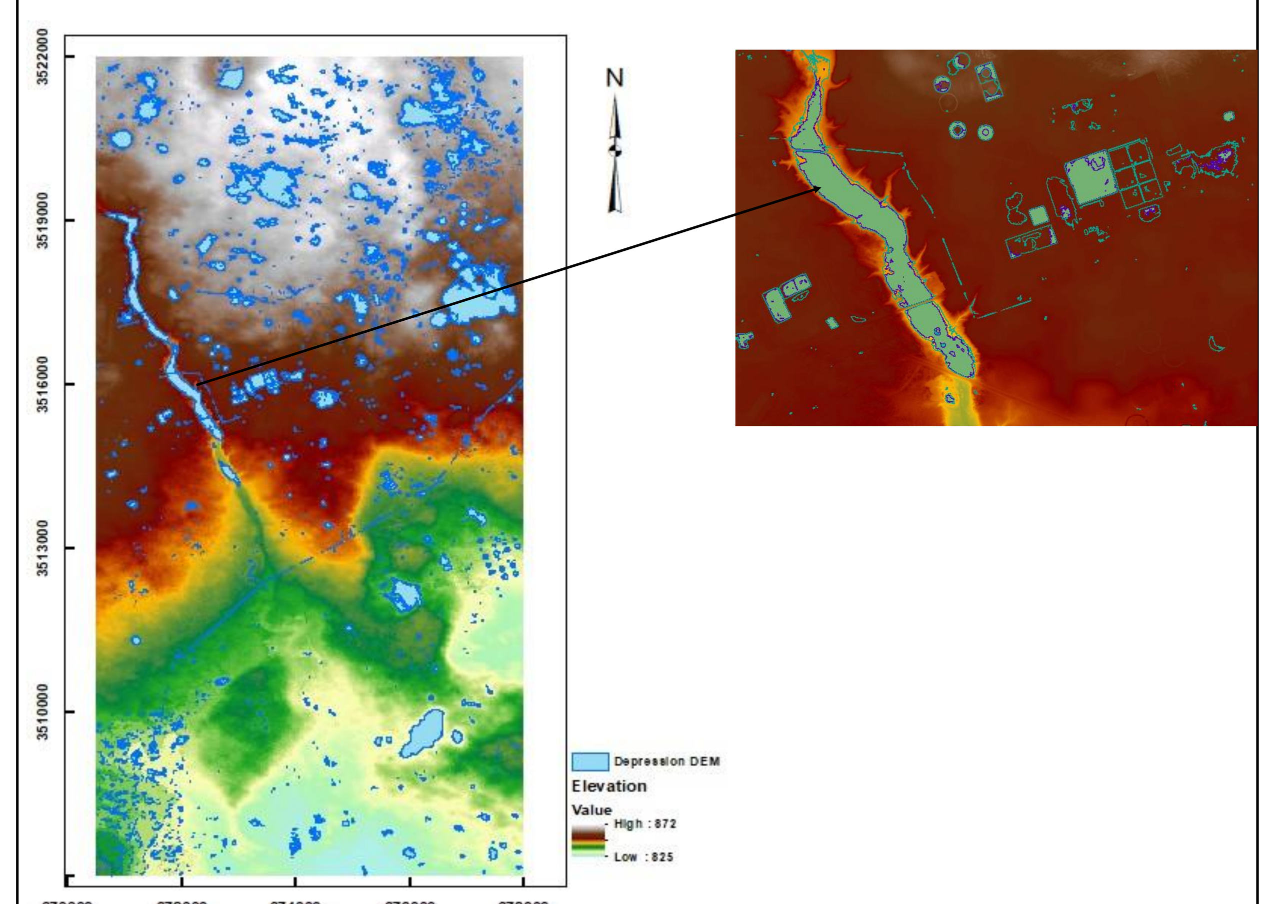
Point cloud Preparation → Creating DEM → Extract DEM depression → Extract Sinkhole contour → Eliminate Non-sinkholes → Sinkhole mapping — Calculate Geometric properties

RESULTS



The above two existing sinkholes , names Wink sink 1 and 2 are formed in 1980 and 2002, respectively. Wink 1 measured 115 m across and 20 m depth. Wink sink 2 measured 240 m across and 25 m depth.

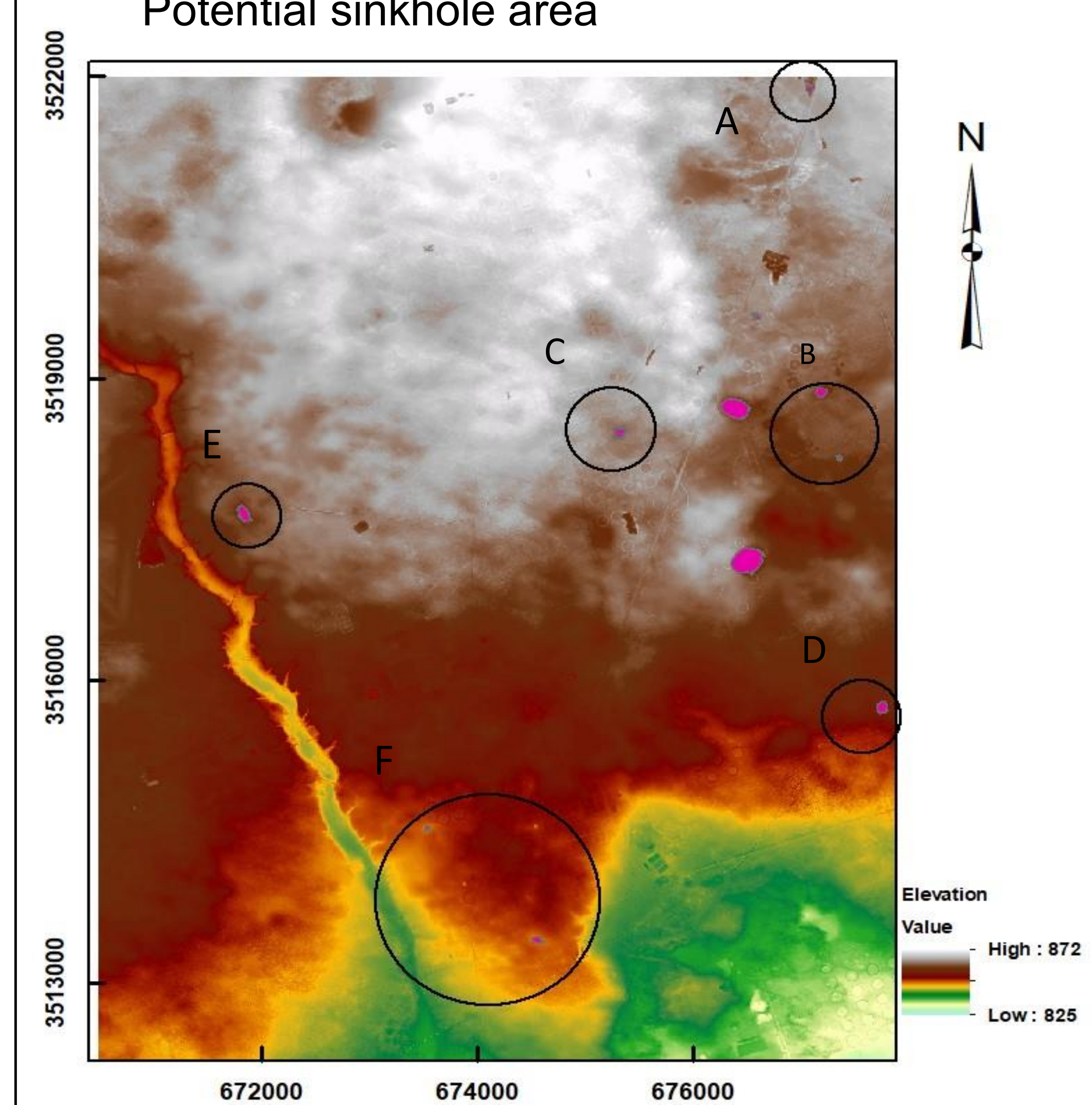


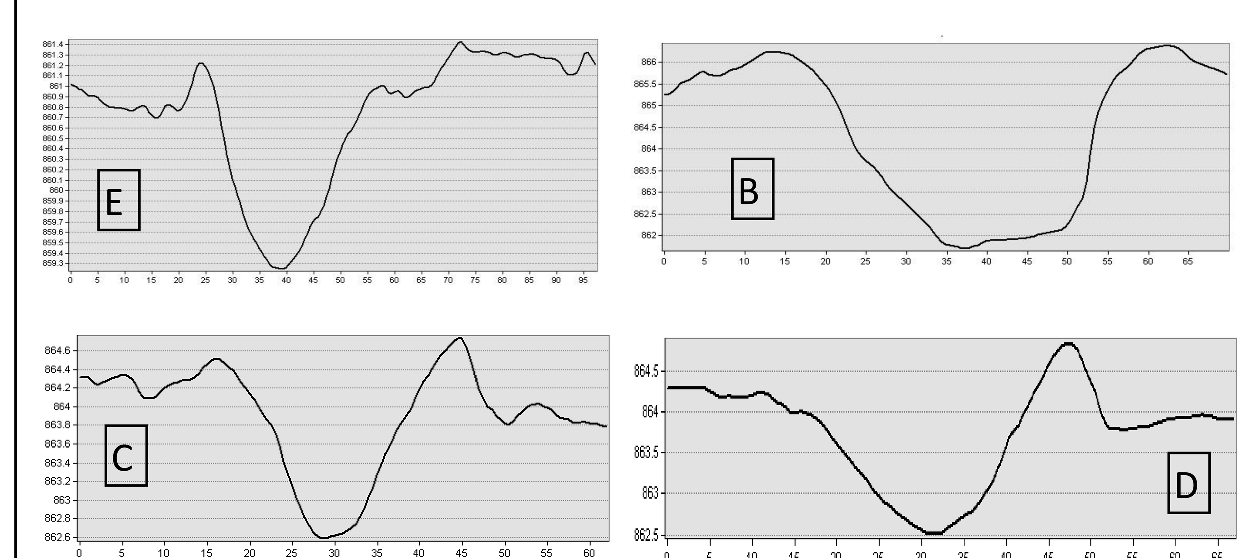


Criteria (depth, width, perimeter and geometric characteristics were used to eliminate non-sinkholes from the identified polygons.

RESULTS

Potential sinkhole area





DISCUSSION/CONCLUSION

- The LiDAR-based remote sensing technique can be a potential means to effectively and accurately detect sinkholes.
- Geometric characteristics of detected sinkholes can be easily quantified by GIS and Remote sensing data.
- Most newly identified sinkholes are formed very close to existing sinkholes.
- Depressions A to F were selected for further ground investigation.
- The data collected on 2010 and therefore might miss sinkholes which are formed after that time.

REFERENCE

Rajabi, A. (2018). Sinkhole Detection and Quantification Using LiDAR Data.

Kim, Y. J., Nam, B. H., & Youn, H. (2019). Sinkhole Detection and Characterization Using LiDAR-Derived DEM with Logistic Regression. *Remote Sensing*, *11*(13), 1592.