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LiDAR Surface Topography of Monroe County, Illinois

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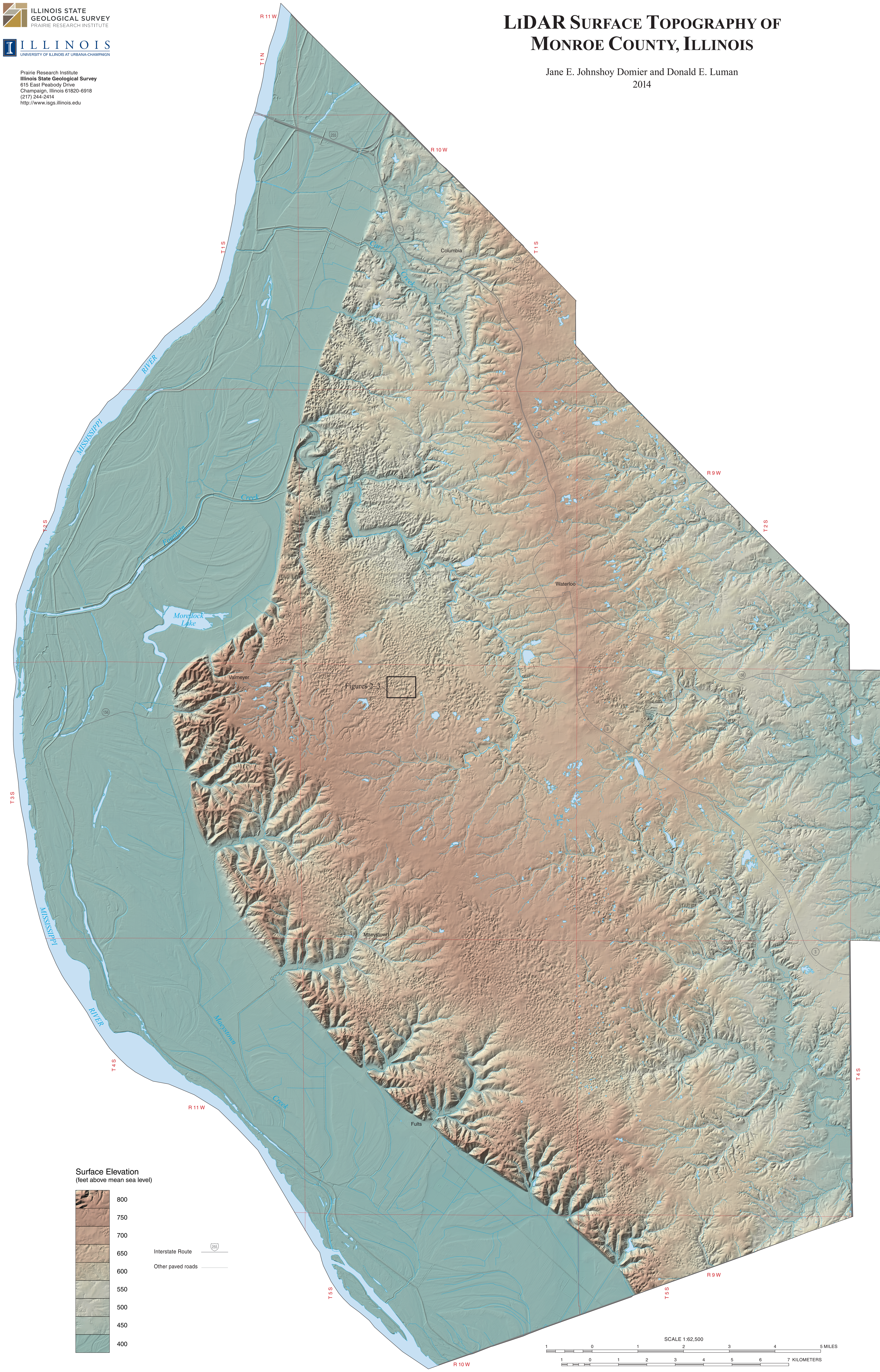
2014



LiDAR Elevation Data

This surface topography map was created from enhanced elevation data acquired using airborne LiDAR (light detection and ranging) technology. This active remote sensing technique uses a pulsating laser sensor to scan the Earth's surface, and the intended application determines the sensitivity of the laser sensor used for data acquisition. For terrestrial applications such as topographic mapping, the principal wavelength selected for most airborne laser sensors is 1,064 nm, which is within the near-infrared band of the electromagnetic spectrum.

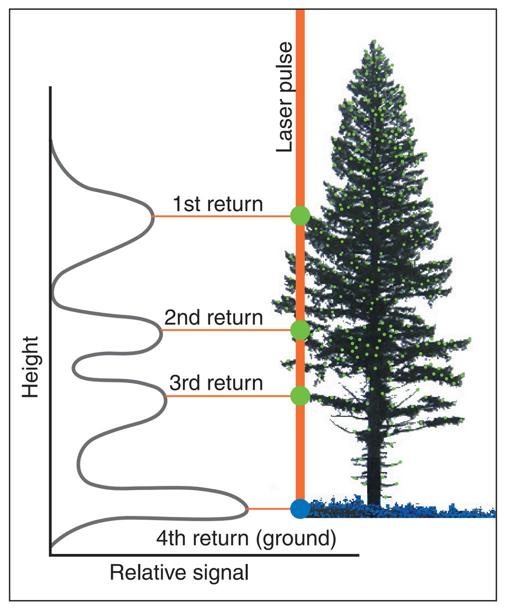


Figure 1 Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR point cloud (colored dots), which is used to generate a three-dimensional representation of the target (revised from Mangold and Van Sickle 2008).

The first object contacted by a laser pulse and reflected back to the sensor is designated as a "first return," which may be a hard target, such as a building rooftop or the ground surface, or a soft target, such as vegetation. When a laser pulse encounters a soft target, e.g., a tree, a portion of the laser beam continues downward and reflects from the underlying branches and trunk, providing additional returns recorded by the laser sensor (Fig. 1). The reflected light pulses are detected by instruments that record the accurate location of each return pulse in three dimensions—(x) and (y) horizontal coordinates and (z) elevation values. The processed returns, which number in the billions for a typical county area, are termed a "point cloud."

A portion of the processed returns represent the ground surface and are referred to as the "bare-earth" point cloud. To maximize the probability of acquiring sufficient ground returns in vegetated terrain, LiDAR is collected in the Midwest during the leaf-off portion of the year when deciduous tree canopies are barren, crops are absent, and most other vegetation types are dormant. However, wherever filtered daylight can pass through vegetated canopy, a portion of the laser pulses reach the surface and produce ground returns.

The bare-earth point cloud, comprising only ground returns, was processed to create a digital terrain model (DTM), which was used to produce the *LiDAR Surface Topography of Monroe County, Illinois*. The extraordinary feature detail contained in the DTM is illustrated in the 1:4,800-scale enlargement of the karst sinkhole features in Figure 2. In contrast, processing all the returns in the LiDAR point cloud produces a digital surface model (DSM) that characterizes the remaining landscape features for the area (Fig. 3). Wooded areas, buildings, and other structures are all apparent on the DSM. The returns representing these aboveground features are filtered from the all-returns point cloud to create a DTM. The airborne LiDAR data collected for Monroe County and the surrounding counties (Fig. 4) average at least one return for each square meter of land surface. This point density, coupled with the exceptional vertical accuracy of LiDAR enhanced elevation data, meets the National Standard for Spatial Data Accuracy for the creation of 2-foot contours.

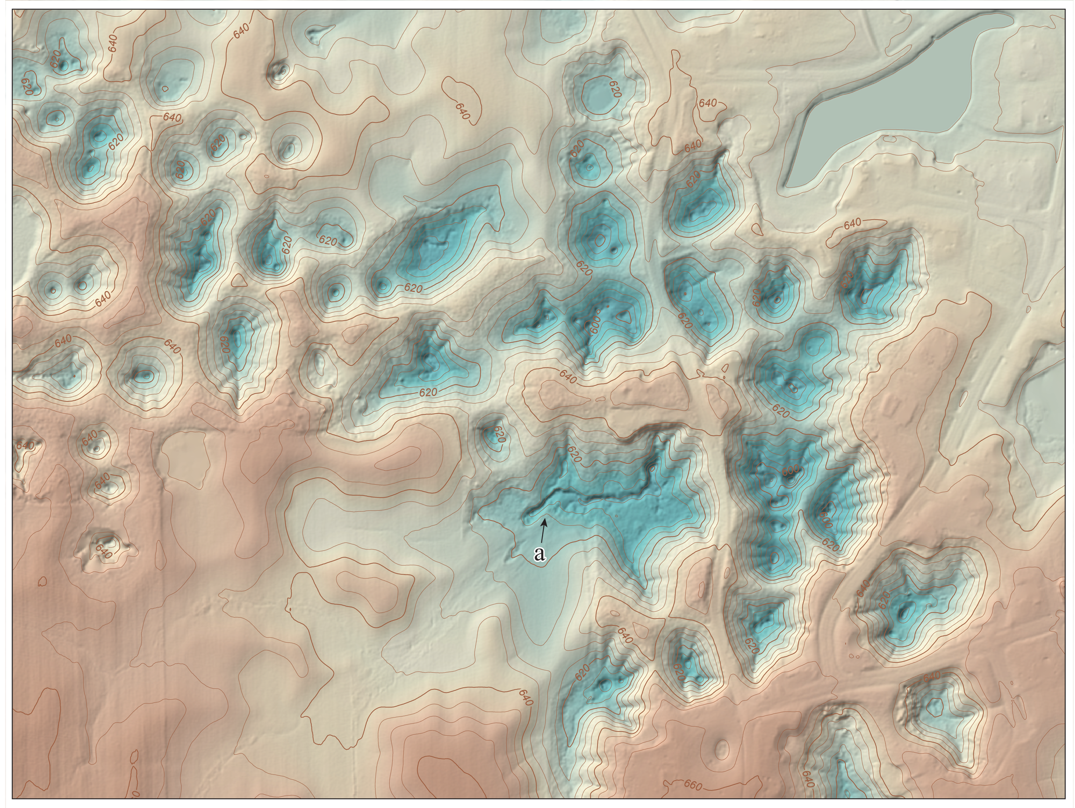


Figure 2 LiDAR digital terrain model (DTM) showing an area of approximately 0.25 square mile exhibiting a high density of sinkhole features, ranging in depth from about 20 feet to more than 50 feet (T35S, R10W). A DTM represents only the ground surface and is extracted from airborne LiDAR data using automated filtering methods to produce what is commonly referred to as a "bare-earth" point cloud. Monroe County is located in southwestern Illinois within the Sinkhole Plain, which contains the highest concentration of karst features within the state. It is estimated that the region contains more than 10,000 sinkhole features, making them distinctive landscape elements within the county. Sinkholes begin with the collapse of unconsolidated sediments into a bedrock crevice or cavity, and because the entire region is underlain by highly erodible limestone, geologic conditions are optimal for sinkhole creation. Disappearing streams are another characteristic feature of karst terrain, and an example is shown at (a). Contour interval is 5 feet. Scale is 1:4,800 (1 in. = 400 ft).

References

Mangold, R., and J. Van Sickle, 2008, Points of light, *in* Point of beginning, February 1, 2008, http://www.pobonline.com/articles/91662-points-of-light (accessed March 30, 2014).

U.S. Geological Survey, 2014, The National Map Viewer and Download Platform, http://viewer.nationalmap.gov/viewer/ (accessed March 30, 2014).

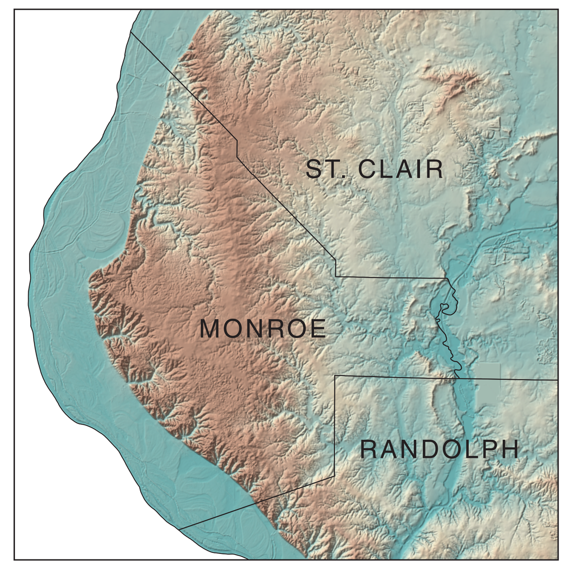


Figure 4 Generalized surface topography for a portion of southwestern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2014).

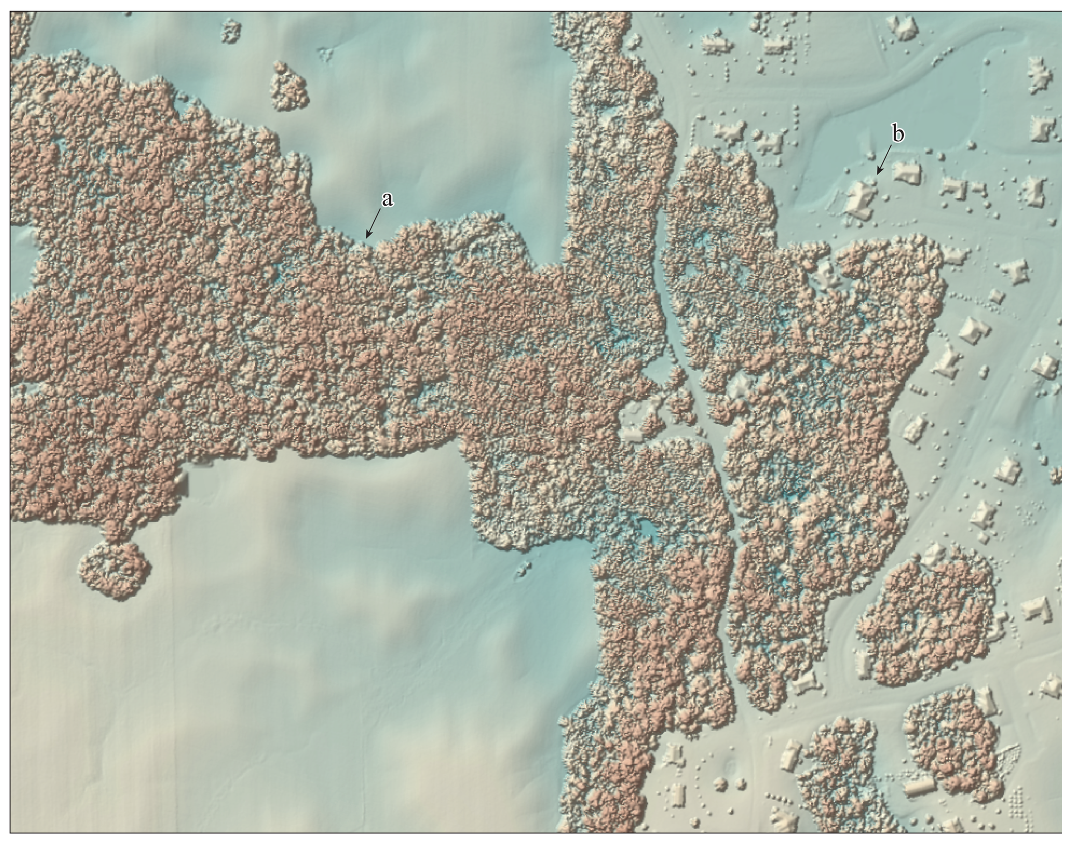


Figure 3 LiDAR-based digital surface model (DSM) of the same area shown in Figure 2. In contrast to a DTM, which represents only ground features, a DSM portrays all aboveground features. The areas of Monroe County that contain the densest and deepest sinkhole features are also densely wooded. Because trees and other vegetation are all aboveground features, they are retained on a DSM (a), completely obscuring the underlying sinkhole and disappearing stream features visible on the DTM. Also, note that houses and other building structures (b) are retained on this DSM. Scale is 1:4,800 (1 in. = 400 ft).

2012 LiDAR data for Monroe County, Illinois, made available through the Illinois Height Modernization Program (http://www.isgs.illinois.edu/nsdihome/webdocs/ilhmp/). Universal Transverse Mercator, zone 16. North American Datum of 1983 (NSRS2007), North American Vertical Datum of 1988. Vector base data from 2013 TIGER/Line Shapefiles provided by the United States Census Bureau.

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