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# LiDAR Surface Topography of St. Clair County, Illinois

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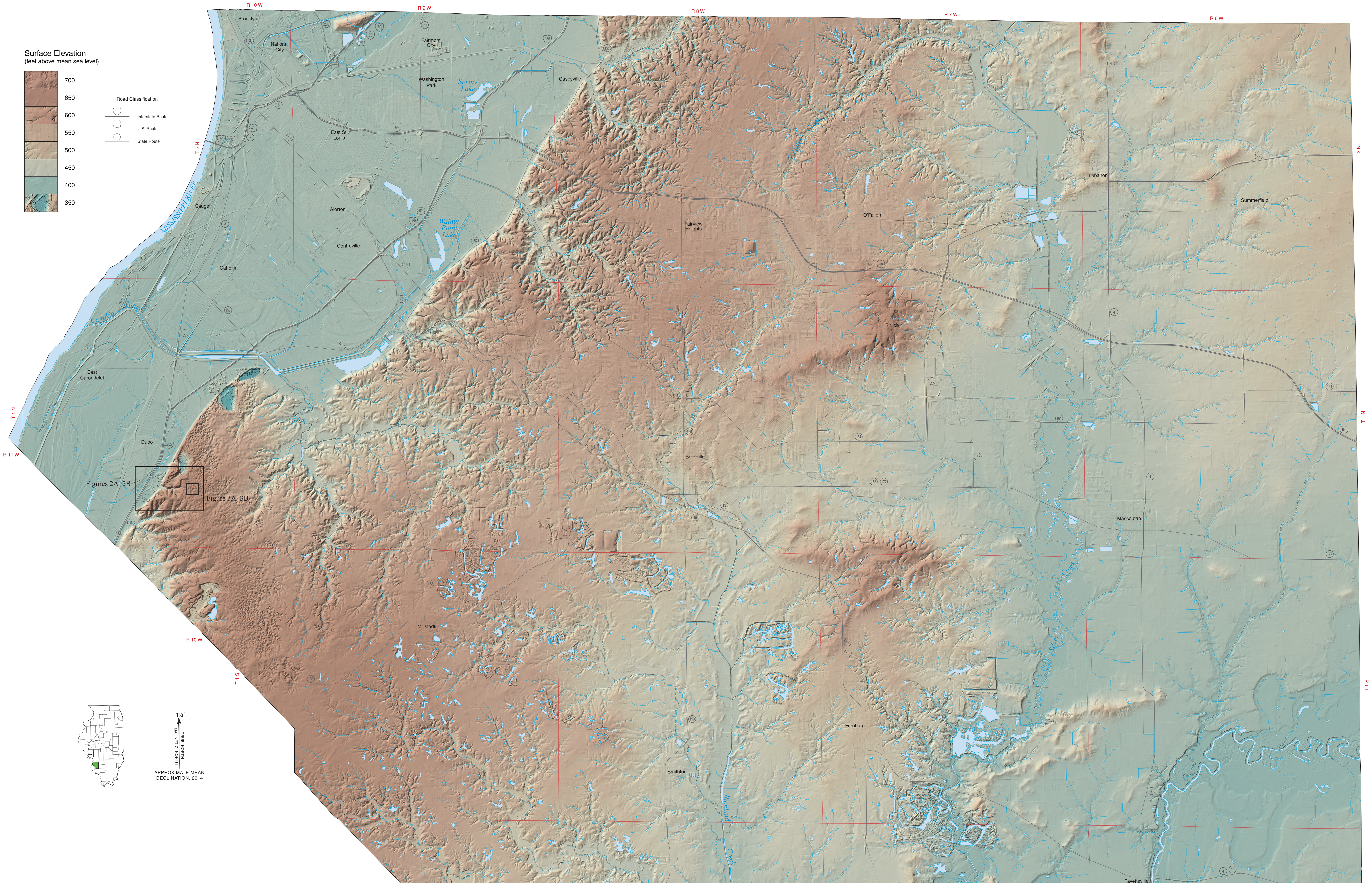
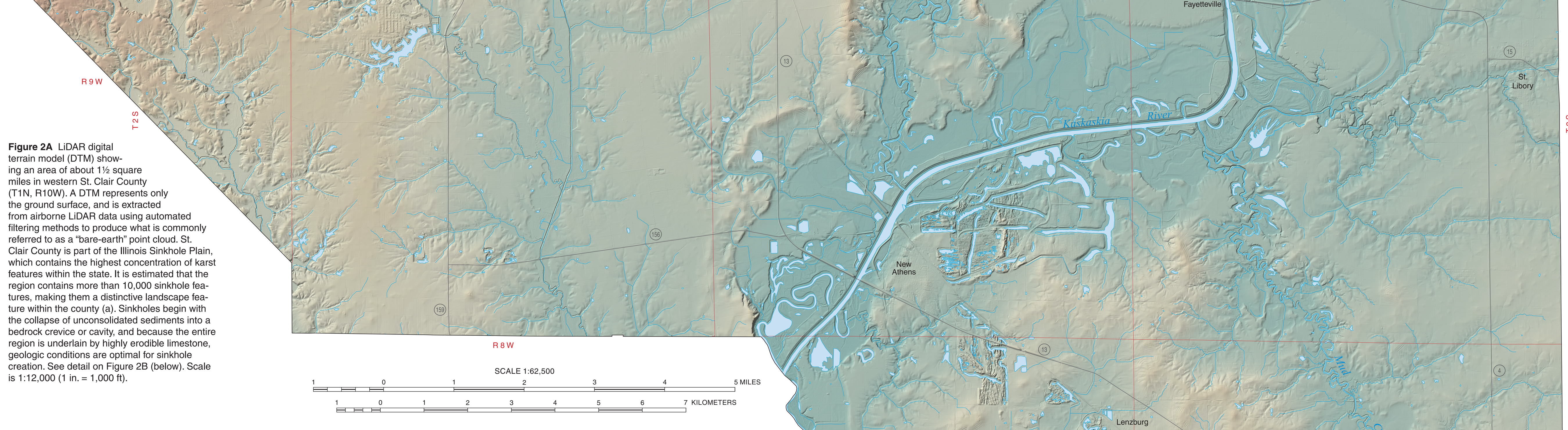
2014

Illinois County Geologic Map
ICGM St. Clair-ST



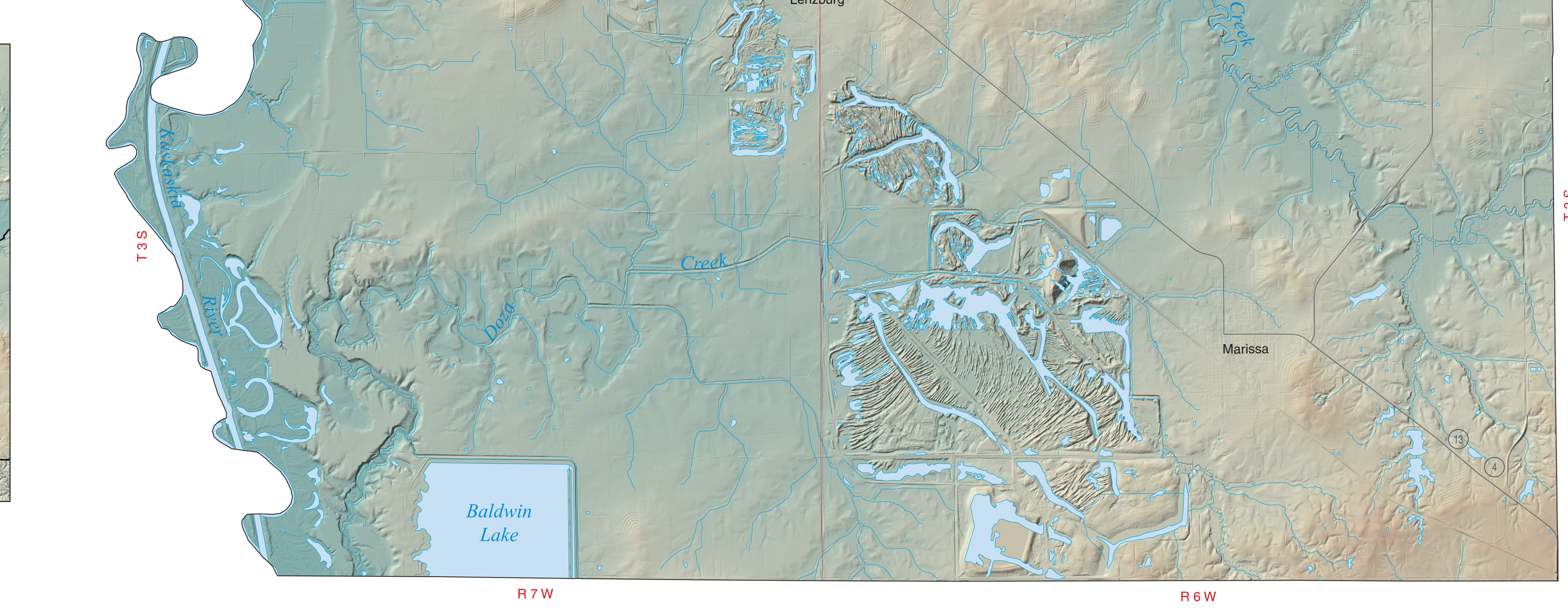



**Figure 2A** LiDAR digital terrain model (DTM) showing an area of about 1½ square miles in western St. Clair County (T1N, R10W). A DTM represents only the ground surface, and is extracted from airborne LiDAR data using automated filtering methods to produce what is commonly referred to as a "bare-earth" point cloud. St. Clair County is part of the Illinois 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 a distinctive landscape feature within the county (a). 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. See detail on Figure 2B (below). Scale is 1:12,000 (1 in. = 1,000 ft).

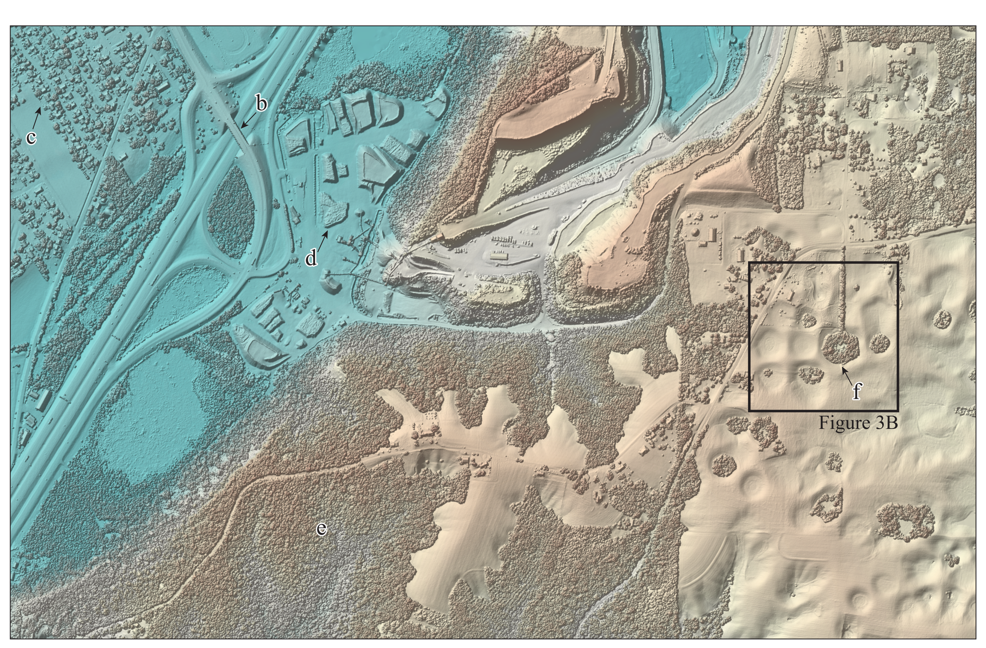



**Figure 2B** LiDAR digital surface model (DSM) of the same area shown in Figure 2. In contrast to a DTM, which represents only ground features, a DSM portrays all aboveground features. Compare the features on this DSM with how they appear on the corresponding DTM. For example, note how the road overpass (b) has been removed on the DTM because that portion of the roadway is not at ground level. All aboveground building structures are retained on the DSM (c), but have been removed on the DTM; however, the large gravel mounds in the quarry remain because they are considered ground features (d). The obscuring tree cover on the steep slopes has been removed on the DTM (e), revealing the details of the underlying stream drainage and the densely wooded sinkhole features (f). See Figure 3B. Scale is 1:12,000 (1 in. = 1,000 ft).

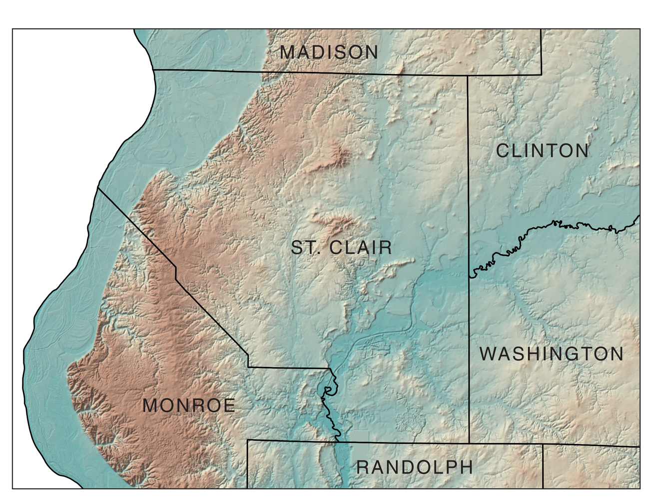



**Figure 4** Generalized surface topography for a portion of southwestern Illinois produced from the U.S. Geological Survey, one-third arc second resolution National Elevation Dataset (U.S. Geological Survey 2014).

## 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.

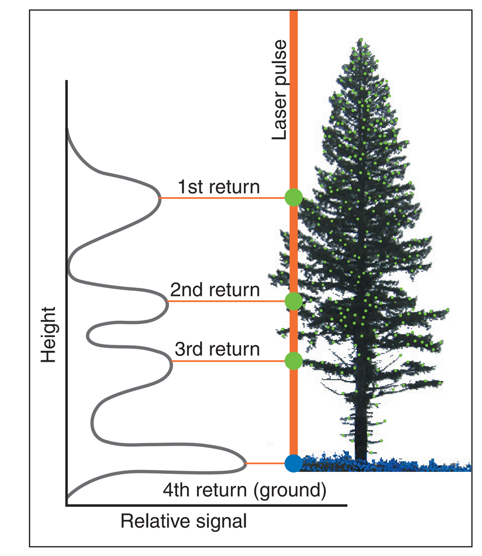



**Figure 1** Simplified illustration of a single laser pulse interacting with a soft target (the tree). A maximum of four returns are possible from each pulse, and current airborne systems can emit more than 150,000 pulses per second. The waveform data collected from the target are processed into a LiDAR 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.

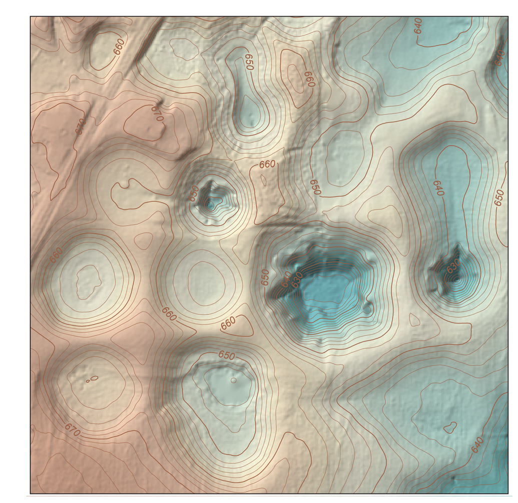


**Figure 3A** LiDAR DTM of a dense concentration of sinkhole features. Contour interval is 2 feet. Scale is 1:3,600 (1 in. = 300 ft).

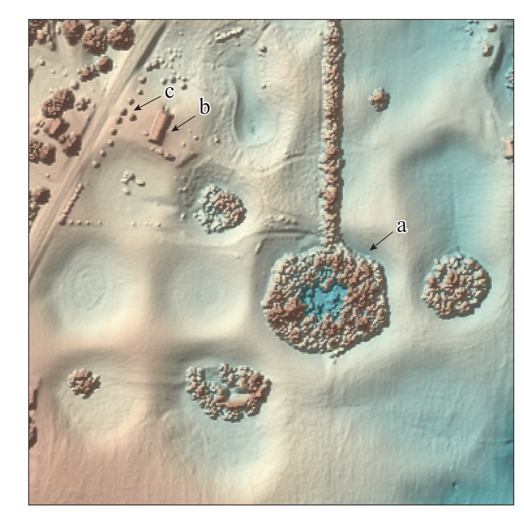


**Figure 3B** LiDAR DSM of the same area shown in Figure 3A. Dense woodland vegetation (a) completely obscures the interior slopes of several of the sinkholes. Note how the building at (b) and the landscape vegetation (c) have been removed on the DTM. Scale is 1:3,600 (1 in. = 300 ft).

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 St. Clair County, Illinois*. The extraordinary feature detail contained in the DTM is illustrated in the enlargements of the karst sinkhole features in Figures 2A and 3A. 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 same area (Figs. 2B and 3B). 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 St. Clair 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 (Fig. 3A).

## 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).

2012 LiDAR data for St. Clair 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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